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ASSESSMENT OF THE GROUND SOURCE HEAT PUMP PERFORMANCE IN 27 HOMES

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ABSTRACT

Twenty seven GSHP installed homes were monitored beginning the heating season of 1987, to determine the feasible residential conservation potential which should result in lowering the system load demand. The monthly energy load profiles of each of these homes and their average thermal and GSHP loads were calculated. It was found that there were two types of homes: those which needed little or no back-up heating and those which needed back-up heating. The latter type of homes were found to be mostly from the Richmond Hill area which tend to have larger energy consumptions. It was estimated that the GSHPs save about 25% of the heating energy requirements.

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1. INTRODUCTION

Little is known about the capabilities and performance of ground source heat pumps (GSHP). GSHP's are machines that remove heat from the ground or groundwater to provide heat at temperatures suitable for space heating and/or hot water heating. The principal advantage of a GSHP is that it delivers 2-1/2 to 3 times more energy to the heated space than what is consumed by its electrically-driven compressor and associated equipment. This means that compared to conventional electric resistance heating, energy costs can be reduced. Ontario Hydro's interest in acquiring practical data on the GSHP's performance has led to an overall research effort to determine the feasible residential conservation potential in Ontario which should result in lowering the system load demand. The Utilization Section of Electrical Research requested the Statistics Unit to provide assistance in evaluating the performance of GSHP's installed in several homes across Ontario. The principal objective of this project was to determine the relative conservation potential of a GSHP.

2. THE DATA

GSHPs were installed in 33 homes all over Ontario, but only 27 of these homes have monitored data available. The Remote Interrogation Monitoring System (RIMS) with four to eight channels was used to meter the GSHP, water heating, back-up heating which is the plenum, and the total loads. Attachment I gives a list of these homes and their corresponding channel descriptions. The monitoring of some of these houses have started in the heating season of 1987. For this study, the 1988 data of all these homes was used. There are a number of houses, however, that do not have data for the whole year, but analysis was still performed. These readings are recorded at 15 minute intervals. The Program Testing and Analysis Department of the Program Support and Services Division provided the Statistics Unit with the hourly monitored data in a standard DALAS text. The pulses were converted to engineering units like kW. The Statistics Unit then converted these files into the desired format for later analysis. A test program was used to detect and eliminate bad data. The conditions set to detect and eliminate bad hourly data were: i) when a stretch of zeros occur on all channels, and ii) when the plenum load was greater than 2 kW along with GSHP load less than 1 kW. When one of the above conditions was true the whole day's data was eliminated. The hourly data were further reduced to daily data. Aside from the monitored data, hourly outdoor temperature data were also gathered. The outdoor temperature data came from the following weather stations: Toronto International Airport, Earlton, London, St. Catherines, Sault Ste. Marie, North Bay, Ottawa, and Thunder Bay. These were used accordingly with the locations of the homes (see Attachment II).

The SAS system software was used for the data extraction and analysis. The analysis included average daily and average monthly demand load profiles. Regressions/1/ were performed to estimate potential residential conservation.

3. ANALYSIS

3.1 Monthly Load Profiles

For each customer's home, the monthly load profile for the total load, GSHP load, and the plenum heater load was created. For some of these homes, a water heating back-up load or a well-pump load is also included in the profiles. These monthly load profiles were calculated by taking the sum of the hourly loads over all the available days in a given month and dividing it by the number of hours of the month. In addition to these, two other loads were also calculated: the appliance load, which was derived by subtracting the GSHP and plenum loads from the total load, and the thermal load, which was calculated by taking the sum of the plenum load, and the product of the GSHP load and the Coefficient of Performance (COP)/2/. The COP is defined as the ratio of the Total Useful Output and the Total Electrical Input and for the GSHP, it would be the ratio of the Total Heat Pump Output and the Total Heat Pump Electrical Input. These COPs based on actual spot measurements taken at the homes were provided by the Electrical Research Department. Thus, the thermal load represents the equivalent of energy consumed by an all-electric home. The thermal load is calculated for the heating season only to depict the load for space heating which is of interest for this study. With these data, demand savings in kW per month can now be calculated for each customer. The demand saving is the difference between the thermal load and the sum of the GSHP and Plenum load or simply the product of the GSHP load and (COP-1). This suggests that a larger value for the COP will give larger demand saving. Tables 1 through 27 and Figures A.1 through A.27 provide the summary and the graphical presentation respectively of the monthly loads for each of the 27 homes. These tables also provide demand savings per month to the customer.

3.2 Average Demand Load Profiles

It was observed from the monthly load tables that some of these homes practically did not use or had little use for back-up heating. Therefore, the 27 homes were divided into two categories; homes that needed little or no use of back-up heating and homes that used back-up heating. The homes that needed the back-up heating are mostly located in the Richmond Hill area and will be labeled as Type II homes. These are the homes of customers #37 through #41. The homes that needed little or no back-up heating will be labeled Type I homes.

It is known that the outdoor temperature influences the electric consumption of the home for space heating; the colder the outdoor temperature the higher the electric consumption. It is also known from past experience that energy consumption is a linear function of the outdoor temperature. In order to establish this relationship, linear regressions were performed on the thermal and GSHP loads with the outdoor temperature. But there was a problem of choosing between hourly and daily average outdoor temperature data for these regressions. It was decided to reject the hourly temperature data because:

i) there is a few hours of lead time (unknown) before any change in the outdoor temperature is noticed inside the home (ie., change in indoor temperature), and

ii) the hourly temperature does not provide any significant change in system peak profile.

The data used for the average demand load profiles were those of the heating season months of the year 1988. The heating season months are from October through April. For the Type I homes, regressions were performed on the thermal and GSHP loads with daily average outdoor temperature. The average demand profile presents two regression lines, the thermal load and GSHP load fitted lines. This shows a visual comparison of the average energy consumption with GSHP installed in a Type I home and its corresponding energy consumption if it was an all-electric home. Note that the scatter plots of the data are not shown on the regression figures because the points were so crowded that no useful inference could be made. The figures also looked very messy, and it was decided to draw the regression lines only.

The area between the two regression lines represents the possible average system load reduction from the GSHP installed Type I home. For example, in the case of customer #20 at New Liskeard location, the outdoor temperature of Earlton weather station was used for the regression (see Attachment II). The coldest temperature based on a daily average for that year was -26° C. Substituting this temperature value to the thermal load and GSHP load equations in Attachment III, give values of 9.4 kW and 4.7 kW, respectively. This suggests a possible system load reduction of 9.4 - 4.7 = 4.7 kW for that outdoor temperature. This can be seen graphically in figure B.2.

For the Type II homes, regressions were also done on the thermal loads and the daily average outdoor temperature to represent the average energy consumption as if they were all-electric homes. These regressions for the GSHP load and the outdoor temperature were performed with some modifications. Since the GSHPs have fixed output capacity, on colder days these homes needed the plenum heater as a back-up for heating the homes. From experience, it has been noted that the plenum heater would usually come on at an outdoor temperature of around -3°C (designated as the balance point temperature). So, a typical Type II home would be using the GSHP only for space heating at greater than or equal to -3°C and for temperatures below -3°C, both the GSHP and the plenum heater combined would meet the heating load of the home. However, for each of these homes, the balance point temperature varies. To depict the relationship between the average GSHP and plenum loads with the outdoor temperature in a Type II home, the balance point temperature must be estimated. With this temperature known, a regression with the plenum load and the outdoor temperature can be performed for outdoor temperatures greater than or equal to this temperature. And for outdoor temperatures less than the balance point temperature, a regression on the sum of the GSHP and plenum loads with the outdoor temperature would be performed.

Since the balance point temperature is unknown, a series of regression iterations were performed to estimate this temperature. To start with, the data were truncated at -3°C to perform the regressions on GSHP+plenum heater loads and on GSHP load with the outdoor temperature. Then, these regression lines were checked to see whether the two lines meet at -3°C. If they did, then -3°C was considered to be the balance point temperature otherwise another truncation point was picked. This was usually the point where the two lines had intersected and then another set of regressions were performed. The same procedure was repeated until such time that the truncation point and the intersection point of the regression lines were almost the same. This was then designated as the balance point temperature for that particular Type II home. An example of the average demand profile of a Type II home is that of customer #40 in Figure B.20. The balance point temperature is at -2.4°C. A knee is observed at that point suggesting that the plenum heater is starting to come on at that temperature. The coldest temperature based on a daily average at the Toronto International Air-

port weather station was -17°C. The average thermal load and the GSHP+plenum loads are 16.2 kW and 8.6 kW, respectively. This corresponds to an average power demand savings of 16.2 - 8.6 = 7.6 kW.

The average demand profiles of all the homes are given in Figures B.1 through B.27. List of regression equations for the thermal and GSHP loads is given in Attachment III. Attachment III also provides the balance point temperatures for the Type II homes.

4. CONCLUSIONS

Based on the analysis, the following observations are made:

- GSHP installed home could significantly (about 25%) lower the energy consumption compared to an all-electric home.
- Two types of homes were identified. The Type I homes needed little or no back-up heating and the Type II homes needed significant back-up heating.
- The Richmond Hill area homes have larger energy consumption compared to the other homes.

5. RECOMMENDATIONS

- It is recommended that similar analysis should be carried out for the rest of the monitored data when it becomes available to test the validity of the conclusions.
- It is also recommended that further studies be done on the assessment of the GSHP efficiency, size, and relevant costs.

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Table 1

YEAR 1988 (WINTER)
CUSTOMER #14
OAKVILLE
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN	5.05	3.56	0.13	1.36	2.50	9.03	5.34
2	FEB	5.17	3.70	0.25	1.23	2.50	9.50	5.55
3	MAR	4.19	3.04	0.02	1.14	2.60	7.92	4.86
4	APRIL	3.12	2.01	0.00	1.11	2.70	5.43	3.42
5	MAY	1.76	0.81	0.00	0.95			
6	JUNE	1.96	1.04	0.00	0.92			
7	JULY	2.21	1.42	0.00	0.79			
8	AUG	2.41	1.46	0.00	0.95			
9	SEP	1.55	0.55	0.00	1.00			
10	OCT	2.62	1.40	0.00	1.21	2.80	3.92	2.52
11	NOV	3.25	2.01	0.00	1.25	2.70	5.43	3.42
12	DEC	4.59	3.07	0.00	1.52	2.60	7.98	4.91

Table 2

YEAR 1988 (WINTER)
CUSTOMER #20
NEW LISKEARD
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	WHB	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN	4.52	3.78	0.03	0.65	0.05	2.00	7.59	3.78
2	FEB	4.60	3.86	0.01	0.66	0.06	2.00	7.73	3.86
3	MAR	4.18	3.07	0.01	0.76	0.35	2.00	6.15	3.07
4	APRIL	3.12	1.89	0.01	0.76	0.46	2.00	3.79	1.89
5	MAY	1.61	0.55	0.01	0.61	0.45			
6	JUNE	1.39	0.36	0.01	0.64	0.39			
7	JULY	1.45	0.53	0.01	0.57	0.33			
8	AUG	1.27	0.29	0.01	0.65	0.32			
9	SEP	1.50	0.34	0.01	0.76	0.39			
10	OCT	2.16	1.00	0.01	0.78	0.38	2.00	2.01	1.00
11	NOV	2.72	1.65	0.01	0.71	0.35	2.00	3.31	1.65
12	DEC	4.47	3.26	0.01	0.78	0.42	2.00	6.53	3.26

Table 3

YEAR 1988 (WINTER)
CUSTOMER #21
NEW LISKEARD
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	WHB	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN	4.24	2.59	0.01	1.23	0.41	2.20	5.71	3.11
2	FEB	4.53	2.55	0.01	1.53	0.44	2.20	5.62	3.06
3	MAR	4.85	1.62	0.01	2.58	0.64	2.30	3.74	2.11
4	APRIL	4.08	0.72	0.01	2.61	0.74	2.40	1.74	1.01
5	MAY	3.13	0.29	0.01	2.11	0.72			
6	JUNE	2.66	0.39	0.01	1.67	0.59			
7	JULY	2.49	0.55	0.01	1.48	0.45			
8	AUG	3.00	0.78	0.01	1.62	0.59			
9	SEP	2.84	0.32	0.01	1.96	0.55			
10	OCT	3.44	0.74	0.01	2.13	0.56	2.40	1.79	1.04
11	NOV	4.15	1.28	0.01	2.33	0.53	2.30	2.95	1.66
12	DEC	5.69	2.18	0.01	3.06	0.44	2.30	5.02	2.83

Table 4

YEAR 1988 (WINTER)
CUSTOMER #22
NEW LISKEARD
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN APPLNC		COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN	5.85	2.41	0.01	3.42	2.90	7.00	4.58
2	FEB	5.82	2.44	0.01	3.37	2.90	7.09	4.64
3	MAR	4.74	1.87	0.01	2.85	2.90	5.43	3.55
4	APRIL	3.84	1.55	0.01	2.28	2.90	4.51	2.95
5	MAY	2.98	0.87	0.01	2.10			
6	JUNE	3.07	0.59	0.01	2.47			
7	JULY	2.46	0.48	0.01	1.97			
8	AUG	2.37	0.32	0.01	2.04			
9	SEPT	3.15	0.29	0.01	2.85			
10	OCT							
11	NOV							
12	DEC	7.24	2.57	0.52	4.14	2.90	7.97	4.88

Table 5

YEAR 1988 (WINTER)
CUSTOMER #23
NEW LISKEARD
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	WHB	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN								
2	FEB								
3	MAR	3.92	2.17	0.04	1.70	0.16	2.50	5.47	3.26
4	APRIL	2.99	1.39	0.00	1.60	0.35	2.50	3.47	2.09
5	MAY	2.05	0.43	0.00	1.61	0.52	2.50	1.08	0.65
6	JUNE	2.02	0.57	0.00	1.45	0.49	2.60	1.48	0.91
7	JULY	1.89	0.70	0.00	1.19	0.29			
8	AUG	2.31	0.68	0.00	1.63	0.51			
9	SEP	2.62	0.60	0.05	1.97	0.66			
10	OCT	3.03	1.34	0.03	1.66	0.33	2.60	3.51	2.14
11	NOV	3.77	1.96	0.00	1.80	0.27	2.60	5.10	3.14
12	DEC	6.27	2.81	0.72	2.73	0.23	2.50	7.75	4.22

Table 6

YEAR 1988 (WINTER)
CUSTOMER #25
LONDON
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLENUM	APPLNC	WHB	GSHP + PLENUM	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN	2.94	2.20	0.02	0.47	0.25	2.22	2.60	5.74	5.70
2	FEB	3.14	2.22	0.10	0.50	0.32	2.32	2.60	5.87	5.67
3	MAR	2.51	0.68	0.02	1.48	0.33	0.70	2.60	1.79	1.75
4	APRIL	1.90	0.09	0.05	1.46	0.30	0.14	2.70	0.29	0.19
5	MAY	1.12	0.04	0.01	0.76	0.30	0.05			
6	JUNE	1.17	0.04	0.01	0.86	0.26	0.05			
7	JULY	1.91	1.06	0.01	0.60	0.24	1.07			
8	AUG	1.99	1.02	0.01	0.72	0.24	1.03			
9	SEP	1.03	0.17	0.01	0.60	0.25	0.18			
10	OCT	1.55	0.75	0.02	0.51	0.28	0.76	2.80	2.12	2.08
11	NOV	1.77	1.10	0.03	0.42	0.22	1.13	2.70	3.00	2.94
12	DEC	2.89	1.90	0.05	0.61	0.33	1.96	2.60	4.99	4.89

Table 7

YEAR 1988 (WINTER)
CUSTOMER #26
NIAGARA FALLS
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLENUM	APPLNC	WHB	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN	2.60	1.73	0.00	0.50	0.37	2.60	4.50	2.77
2	FEB	2.57	1.71	0.00	0.49	0.37	2.60	4.45	2.74
3	MAR	2.15	1.27	0.00	0.48	0.39	2.60	3.30	2.03
4	APRIL	1.66	0.69	0.00	0.44	0.53	2.70	1.86	1.17
5	MAY	1.10	0.11	0.00	0.53	0.46			
6	JUNE	1.42	0.26	0.00	0.78	0.38			
7	JULY	1.53	0.50	0.00	0.76	0.27			
8	AUG	1.36	0.34	0.00	0.78	0.24			
9	SEP	1.15	0.04	0.00	0.79	0.32			
10	OCT	1.51	0.60	0.00	0.58	0.33	2.80	1.68	1.08
11	NOV	1.89	1.08	0.00	0.54	0.28	2.70	2.92	1.84
12	DEC	2.49	1.62	0.00	0.59	0.27	2.60	4.21	2.59

Table 8

YEAR 1988 (WINTER)
CUSTOMER #27
NIAGARA FALLS
(in kW)

MONTH	TOTAL LOAD	GSHP	PLENUM	APPLNC	VHB	COP	THERMAL LOAD	DEMAND SAVINGS
1 JAN	3.31	2.10	0.09	0.63	0.48	2.60	5.55	3.36
2 FEB	3.35	2.23	0.18	0.62	0.32	2.60	5.98	3.57
3 MAR	2.68	1.70	0.03	0.61	0.35	2.60	4.45	2.72
4 APRIL	1.93	0.95	0.01	0.53	0.44	2.70	2.58	1.62
5 MAY	1.24	0.19	0.01	0.57	0.48			
6 JUNE	1.21	0.24	0.01	0.53	0.43			
7 JULY	1.55	0.66	0.01	0.53	0.35			
8 AUG	1.43	0.56	0.01	0.56	0.31			
9 SEP	0.86	0.01	0.01	0.53	0.31			
10 OCT	2.15	0.53	0.01	1.18	0.43	2.80	1.49	0.95
11 NOV	2.02	0.92	0.01	0.65	0.45	2.70	2.49	1.56
12 DEC	2.96	1.83	0.01	0.72	0.40	2.60	4.77	2.93

Table 9

YEAR 1988 (WINTER)
CUSTOMER #29
CALLANDER
(in kW)

MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	WHB	COP	THERMAL LOAD	DEMAND SAVINGS
1 JAN	10.91	3.07	0.00	7.72	0.11	2.60	7.98	4.91
2 FEB	10.51	2.97	0.00	7.45	0.09	2.60	7.72	4.75
3 MAR	6.49	1.91	0.00	4.48	0.09	2.60	4.97	3.06
4 APRIL	6.53	2.03	0.00	4.40	0.10	2.70	5.48	3.45
5 MAY	6.40	0.96	0.01	5.20	0.24			
6 JUNE	6.92	0.92	0.00	4.22	1.77			
7 JULY	8.13	0.00	0.01	5.50	2.63			
8 AUG	9.04	0.00	0.00	5.44	3.60			
9 SEP	8.61	0.00	0.00	4.65	3.95			
10 OCT	8.41	0.00	0.00	4.28	4.13	2.80	0.00	0.00
11 NOV	8.97	0.09	0.00	4.76	4.12	2.70	0.24	0.15
12 DEC	9.86	2.59	0.00	3.68	3.60	2.60	6.73	4.14

Table 10

YEAR 1988 (WINTER)
CUSTOMER #30
NORTHBAY
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	WHB	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN	3.98	2.85	0.00	0.80	0.33	2.60	7.41	4.56
2	FEB	3.87	2.83	0.00	0.76	0.28	2.60	7.36	4.53
3	MAR	3.35	2.16	0.00	0.79	0.40	2.60	5.62	3.46
4	APRIL	2.67	1.47	0.00	0.78	0.42	2.70	3.97	2.50
5	MAY	1.76	0.64	0.00	0.76	0.37			
6	JUNE	1.36	0.55	0.00	0.59	0.21			
7	JULY	1.68	0.84	0.00	0.61	0.24			
8	AUG	1.67	0.68	0.00	0.70	0.29			
9	SEP	1.47	0.43	0.00	0.73	0.31			
10	OCT	2.39	1.27	0.00	0.79	0.33	2.80	3.56	2.29
11	NOV	3.12	2.05	0.00	0.76	0.31	2.70	5.54	3.49
12	DEC	4.34	3.13	0.00	0.83	0.38	2.60	8.14	5.01

Table 11

YEAR 1988 (WINTER)
CUSTOMER #31
NORTH BAY
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	WHB	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN	2.34	2.16	0.00	0.18	0.00	2.60	5.62	3.46
2	FEB	2.18	2.01	0.00	0.16	0.01	2.60	5.23	3.22
3	MAR	1.95	1.80	0.00	0.13	0.01	2.60	4.68	2.88
4	APRIL	1.76	1.17	0.00	0.42	0.17	2.70	3.16	1.99
5	MAY	0.92	0.46	0.00	0.24	0.22			
6	JUNE	0.93	0.14	0.01	0.53	0.25			
7	JULY	1.78	0.81	0.01	0.69	0.27			
8	AUG	1.27	0.20	0.01	0.77	0.29			
9	SEP	1.24	0.21	0.01	0.75	0.26			
10	OCT	1.42	0.50	0.03	0.70	0.19	2.80	1.43	0.90
11	NOV	1.80	0.54	0.03	0.81	0.42	2.70	1.49	0.92
12	DEC	3.16	1.44	0.03	1.14	0.55	2.60	3.77	2.30

Table 12

YEAR 1988 (WINTER)
CUSTOMER #32
GREELY
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	WELL PUMP	WSHP	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN	5.54	2.93	0.01	2.05	0.55	3.48	2.90	8.51	5.57
2	FEB	5.06	2.78	0.01	1.73	0.52	3.30	2.90	8.07	5.28
3	MAR	4.34	2.10	0.01	1.83	0.40	2.50	2.90	6.10	3.99
4	APRIL	3.39	1.23	0.01	1.90	0.25	1.48	2.90	3.58	2.34
5	MAY	2.39	0.40	0.01	1.85	0.13	0.53			
6	JUNE	2.56	0.54	0.01	1.81	0.19	0.73			
7	JULY	2.79	0.77	0.01	1.81	0.20	0.97			
8	AUG	2.45	0.53	0.01	1.74	0.17	0.70			
9	SEP	2.20	0.30	0.01	1.81	0.09	0.39			
10	OCT	3.12	0.96	0.01	1.95	0.20	1.16	2.90	2.79	1.82
11	NOV	3.52	1.18	0.01	2.10	0.23	1.41	2.90	3.43	2.24
12	DEC	4.83	1.95	0.01	2.51	0.36	2.31	2.90	5.67	3.70

Table 13

YEAR 1988 (WINTER)
CUSTOMER #33
GREELY
(in kW)

MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	WELL PUMP	WSHP	COP	THERMAL LOAD	DEMAND SAVING
1 JAN	2.75	1.59	0.16	0.71	0.29	1.88	3.10	5.09	3.34
2 FEB	2.33	1.41	0.08	0.59	0.26	1.67	3.10	4.45	2.96
3 MAR	2.15	1.25	0.09	0.58	0.23	1.48	3.10	3.97	2.63
4 APRIL	1.74	0.67	0.12	0.83	0.13	0.80	3.10	2.20	1.41
5 MAY	0.91	0.07	0.03	0.77	0.04	0.11			
6 JUNE	0.92	0.10	0.01	0.70	0.11	0.21			
7 JULY	0.95	0.25	0.01	0.59	0.10	0.35			
8 AUG	0.92	0.20	0.01	0.61	0.10	0.30			
9 SEP	0.75	0.02	0.02	0.67	0.04	0.06			
10 OCT	1.43	0.54	0.07	0.70	0.11	0.65	3.10	1.74	1.13
11 NOV	1.81	0.89	0.09	0.66	0.17	1.06	3.10	2.85	1.87
12 DEC	2.70	1.47	0.15	0.82	0.26	1.73	3.10	4.71	3.09

Table 14

YEAR 1988 (WINTER)
CUSTOMER #34
GREELY
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	WELL PUMP	WSHP	COP	THERMAL LOAD	DEMAND SAVING
1	JAN	3.10	1.64	0.01	0.98	0.47	2.11	2.70	4.44	2.79
2	FEB	3.48	1.80	0.01	1.15	0.51	2.31	2.70	4.87	3.06
3	MAR	3.29	1.67	0.01	1.12	0.48	2.15	2.70	4.52	2.84
4	APRIL	2.63	1.01	0.01	1.30	0.31	1.32	2.70	2.74	1.72
5	MAY	2.20	0.59	0.01	1.38	0.22	0.81			
6	JUNE	2.04	0.49	0.01	1.29	0.25	0.74			
7	JULY	2.49	0.80	0.01	1.32	0.37	1.17			
8	AUG	2.20	0.60	0.01	1.34	0.26	0.86			
9	SEP	1.73	0.25	0.01	1.36	0.10	0.35			
10	OCT	2.61	0.87	0.02	1.43	0.29	1.16	2.70	2.37	1.48
11	NOV	3.13	1.22	0.01	1.33	0.58	1.80	2.70	3.30	2.07
12	DEC	4.42	1.96	0.01	1.41	1.03	2.99	2.70	5.30	3.33

Table 15

YEAR 1988 (WINTER)
CUSTOMER #35
GREELY
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	WELL PUMP	WSHP	COP	THERMAL LOAD	DEMAND SAVING
1	JAN	3.69	2.02	0.00	1.04	0.63	2.65	2.00	4.04	2.02
2	FEB	3.50	1.94	0.00	0.96	0.59	2.53	2.00	3.88	1.94
3	MAR	3.04	1.58	0.00	0.99	0.47	2.05	2.00	3.16	1.58
4	APRIL	2.23	0.89	0.00	1.10	0.24	1.13	2.00	1.78	0.89
5	MAY	1.29	0.15	0.00	1.04	0.09	0.24			
6	JUNE	1.29	0.19	0.00	0.99	0.10	0.29			
7	JULY	2.09	0.59	0.00	1.23	0.26	0.85			
8	AUG	1.77	0.40	0.00	1.19	0.17	0.57			
9	SEP	1.16	0.03	0.00	1.12	0.01	0.04			
10	OCT	1.94	0.60	0.00	1.14	0.19	0.79	2.00	1.20	0.60
11	NOV	2.68	1.09	0.00	1.24	0.35	1.44	2.00	2.18	1.09
12	DEC	3.90	1.94	0.00	1.32	0.64	2.58	2.00	3.88	1.94

Table 16

YEAR 1988 (WINTER)
CUSTOMER #36
GREELY
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	WELL PUMP	WSHP	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN	4.82	2.26	0.00	2.07	0.49	2.75	2.10	4.75	2.49
2	FEB	4.66	2.07	0.00	2.13	0.46	2.53	2.10	4.35	2.28
3	MAR	4.15	1.58	0.00	2.19	0.37	1.95	2.10	3.32	1.74
4	APRIL	3.45	0.79	0.00	2.46	0.21	1.00	2.10	1.66	0.87
5	MAY	2.50	0.14	0.00	2.26	0.10	0.24			
6	JUNE	2.66	0.25	0.00	2.24	0.17	0.42			
7	JULY	2.73	0.39	0.00	2.15	0.18	0.57			
8	AUG	2.56	0.25	0.00	2.19	0.12	0.37			
9	SEP	2.35	0.09	0.00	2.21	0.05	0.14			
10	OCT	3.42	0.67	0.00	2.56	0.19	0.86	2.10	1.41	0.74
11	NOV	4.00	1.20	0.00	2.49	0.32	1.52	2.10	2.52	1.32
12	DEC	5.05	2.01	0.00	2.49	0.55	2.56	2.10	4.22	2.21

Table 17

YEAR 1988 (WINTER)
CUSTOMER #37
RICHMOND HILL
(in kW)

MONTH	TOTAL LOAD	GSHP	PLEN	COP	THERMAL LOAD	DEMAND SAVINGS
1 JAN	3.70	4.37	2.40	2.50	13.33	6.56
2 FEB	3.35	4.16	1.92	2.50	12.32	6.24
3 MAR	2.05	3.29	0.31	2.60	8.86	5.26
4 APRIL	1.07	2.40	0.08	2.70	6.56	4.08
5 MAY	0.63	0.88	0.03			
6 JUNE	0.82	1.14	0.01			
7 JULY	1.17	1.93	0.01			
8 AUG	0.89	1.36	0.01			
9 SEP	0.39	0.32	0.01			
10 OCT						
11 NOV						
12 DEC						

* Total Load may not be valid

Table 18

YEAR 1988 (WINTER)
CUSTOMER #38
RICHMOND HILL
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN APPLNC		COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN	7.65	3.98	1.48	2.18	2.50	11.43	5.97
2	FEB	7.21	4.02	1.27	1.92	2.50	11.32	6.03
3	MAR	5.48	3.42	0.26	1.80	2.50	8.81	5.13
4	APRIL	4.24	2.44	0.02	1.79	2.60	6.36	3.90
5	MAY	2.95	1.42	0.01	1.52			
6	JUNE	3.48	2.07	0.01	1.40			
7	JULY	3.58	2.39	0.01	1.18			
8	AUG	3.54	2.18	0.01	1.35			
9	SEP	3.07	1.41	0.01	1.66			
10	OCT							
11	NOV							
12	DEC							

Table 19

YEAR 1988 (WINTER)
CUSTOMER #39
RICHMOND HILL
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN APPLNC		COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN	9.07	4.40	3.62	1.05	2.40	14.18	6.16
2	FEB	7.88	4.42	2.47	0.99	2.30	12.64	5.75
3	MAR	5.78	3.70	1.17	0.92	2.20	9.31	4.44
4	APRIL							
5	MAY	7.49	5.53	0.32	1.65			
6	JUNE	3.52	1.61	0.01	1.90			
7	JULY	4.13	2.46	0.01	1.66			
8	AUG	4.09	2.36	0.01	1.71			
9	SEPT	3.28	1.44	0.01	1.83			
10	OCT	3.83	2.41	0.01	1.41	2.90	7.00	4.58
11	NOV	4.91	3.59	0.01	1.31	2.80	10.06	6.46
12	DEC	7.05	4.66	1.02	1.37	2.80	14.07	8.39

Table 20

YEAR 1988 (WINTER)
CUSTOMER #40
RICHMOND HILL
(in kW)

MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	COP	THERMAL LOAD	DEMAND SAVINGS
1 JAN	6.37	4.13	1.43	0.82	2.50	11.75	6.20
2 FEB	6.23	4.03	1.47	0.73	2.50	11.55	6.05
3 MAR	5.26	3.74	0.84	0.69	2.50	10.19	5.61
4 APRIL	3.54	2.84	0.03	0.67	2.50	7.13	4.26
5 MAY	2.10	1.42	0.02	0.66			
6 JUNE	1.95	1.22	0.01	0.72			
7 JULY	2.35	1.67	0.02	0.66			
8 AUG	2.42	1.75	0.02	0.65			
9 SEPT	1.75	1.08	0.02	0.66			
10 OCT	2.93	2.16	0.03	0.74	2.90	6.29	4.10
11 NOV	3.82	3.05	0.02	0.75	2.90	8.86	5.79
12 DEC	4.95	4.03	0.13	0.79	2.90	11.82	7.66

Table 21

YEAR 1988 (WINTER)
CUSTOMER #41
RICHMOND HILL
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN							
2	FEB	6.97	2.85	1.99	2.13	2.50	9.12	4.28
3	MAR	6.25	3.17	0.89	2.19	2.50	8.82	4.76
4	APRIL	4.78	2.28	0.30	2.20	2.60	6.23	3.65
5	MAY	3.39	1.50	0.06	1.83			
6	JUNE	3.84	2.23	0.06	1.56			
7	JULY	4.97	3.28	0.00	1.69			
8	AUG	4.49	2.87	0.00	1.61			
9	SEP	4.30	1.69	0.00	2.61			
10	OCT							
11	NOV							
12	DEC							

Table 22

YEAR 1988 (WINTER)
CUSTOMER #76
ECHO BAY
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	WHB	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN								
2	FEB								
3	MAR								
4	APRIL								
5	MAY								
6	JUNE	1.54	0.34	0.01	0.80	0.38			
7	JULY	1.51	0.60	0.01	0.70	0.20			
8	AUG	1.42	0.42	0.01	0.76	0.23			
9	SEP	1.59	0.41	0.01	0.96	0.21			
10	OCT	2.43	1.37	0.01	0.87	0.18	2.80	3.85	2.47
11	NOV	3.36	2.32	0.01	0.91	0.13	2.80	6.51	4.18
12	DEC	4.52	3.09	0.24	1.08	0.11	2.70	8.58	5.25

Table 23

YEAR 1988 (WINTER)
CUSTOMER #77
SAULT STE. MARIE
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN APPLNC		WHB	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN								
2	FEB								
3	MAR								
4	APRIL								
5	MAY								
6	JUNE								
7	JULY								
8	AUG	1.31	0.12	0.00	0.87	0.31			
9	SEP	1.70	0.40	0.00	0.95	0.35			
10	OCT	3.37	1.87	0.00	1.12	0.38	2.80	5.24	3.37
11	NOV	4.33	2.65	0.00	1.33	0.34	2.70	7.16	4.51
12	DEC	6.43	3.08	1.37	1.59	0.39	2.60	9.38	4.93

Table 24

YEAR 1988 (WINTER)
CUSTOMER #78
SAULT STE. MARIE
(in kW)

	MONTH	TOTAL LOAD	GSHP	APPLNC	WNB	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN							
2	FEB							
3	MAR							
4	APRIL							
5	MAY							
6	JUNE							
7	JULY							
8	AUG	1.21	0.59	0.54	0.07			
9	SEP	1.26	0.74	0.51	0.01			
10	OCT	2.11	1.54	0.58	0.00	2.60	4.00	2.46
11	NOV	2.81	2.03	0.78	0.00	2.50	5.07	3.05
12	DEC	3.29	2.59	0.70	0.00	2.40	6.22	3.63

Table 25

YEAR 1988 (WINTER)
CUSTOMER #86
ALLISTON
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	WHB	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN								
2	FEB								
3	MAR								
4	APRIL								
5	MAY								
6	JUNE	2.27	0.46	0.00	1.39	0.42			
7	JULY	4.23	2.23	0.01	1.56	0.44			
8	AUG	4.57	2.39	0.01	1.72	0.45			
9	SEP	3.14	0.56	0.00	2.03	0.54			
10	OCT	5.16	1.99	0.10	2.55	0.52	2.80	5.67	3.58
11	NOV	6.19	2.95	0.16	2.56	0.52	2.80	8.42	5.31
12	DEC	8.04	3.23	0.74	3.52	0.55	2.70	9.46	5.49

Table 26

YEAR 1988 (WINTER)
CUSTOMER #200
KAKABEKA FALLS
(in kW)

	MONTH	TOTAL LOAD	GSHP	APPLNC	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN	4.21	2.94	1.27	2.30	6.76	3.82
2	FEB	4.15	2.85	1.30	2.30	6.56	3.70
3	MAR	3.09	2.11	0.97	2.40	5.06	2.95
4	APRIL	1.98	1.13	0.85	2.50	2.82	1.69
5	MAY	0.99	0.29	0.70			
6	JUNE	0.66	0.09	0.57			
7	JULY	0.91	0.25	0.66			
8	AUG	0.93	0.13	0.80			
9	SEP	1.14	0.14	1.00			
10	OCT	2.21	1.24	0.97	2.50	3.10	1.86
11	NOV	2.98	1.83	1.14	2.40	4.39	2.56
12	DEC	4.39	3.09	1.29	2.40	7.42	4.33

Table 27

YEAR 1988 (WINTER)
CUSTOMER #201
THUNDER BAY
(in kW)

	MONTH	TOTAL LOAD	GSHP	PLEN	APPLNC	WHB	COP	THERMAL LOAD	DEMAND SAVINGS
1	JAN								
2	FEB								
3	MAR	3.39	1.29	0.81	1.29	0.51	2.50	4.04	1.94
4	APRIL	2.50	0.93	0.09	1.48	0.49	2.60	2.51	1.49
5	MAY	1.99	0.28	0.06	1.66	0.53			
6	JUNE	1.81	0.39	0.00	1.42	0.43			
7	JULY	2.27	0.58	0.00	1.69	0.41			
8	AUG	1.55	0.26	0.00	1.29	0.30			
9	SEP	1.54	0.19	0.00	1.35	0.38			
10	OCT	3.06	0.98	0.00	2.08	0.32	2.60	2.55	1.57
11	NOV	4.89	1.71	0.02	3.16	0.25	2.50	4.30	2.57
12	DEC	6.14	1.71	0.41	4.02	0.32	2.40	4.51	2.39

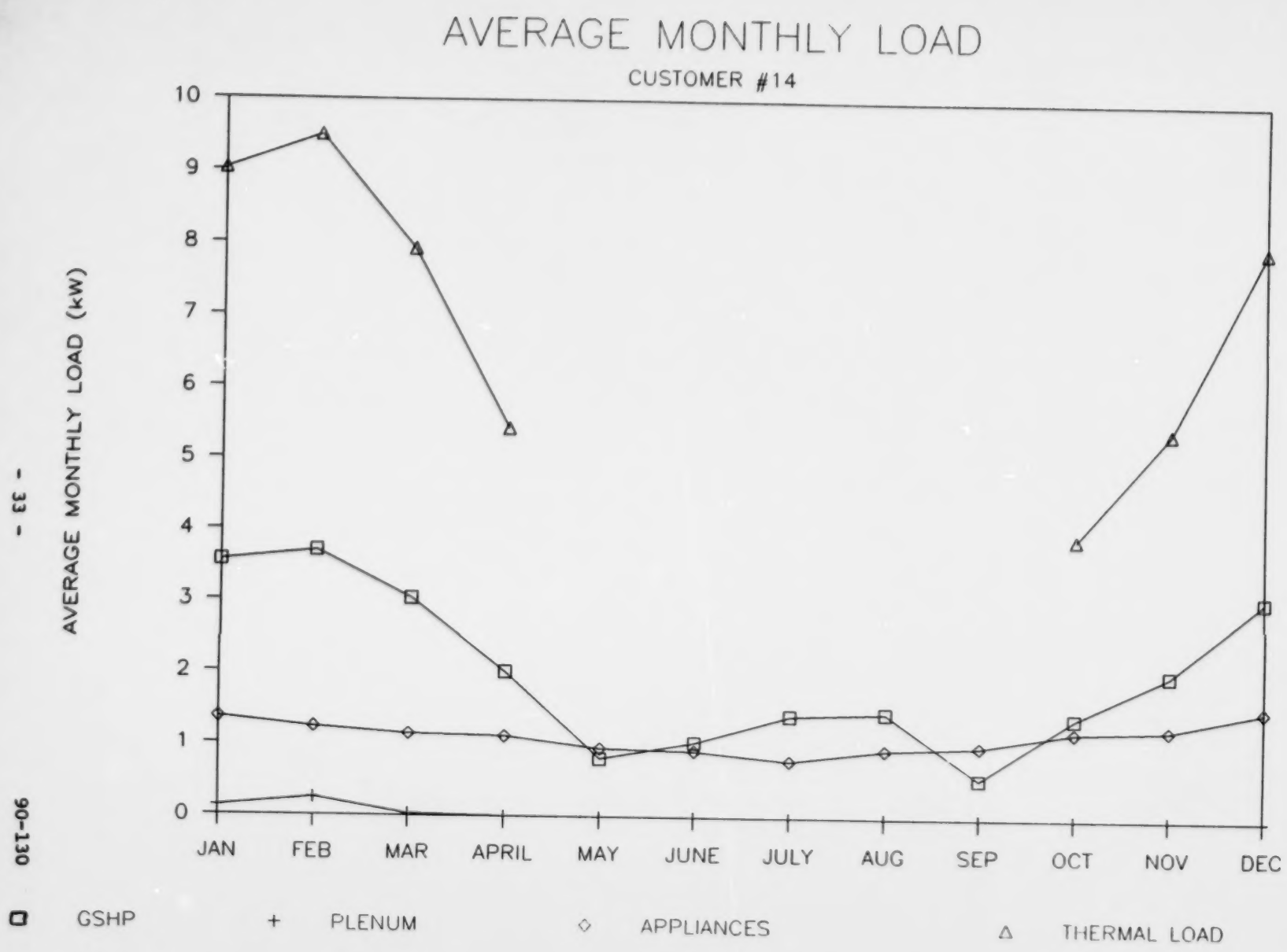


FIGURE A.1

90-130

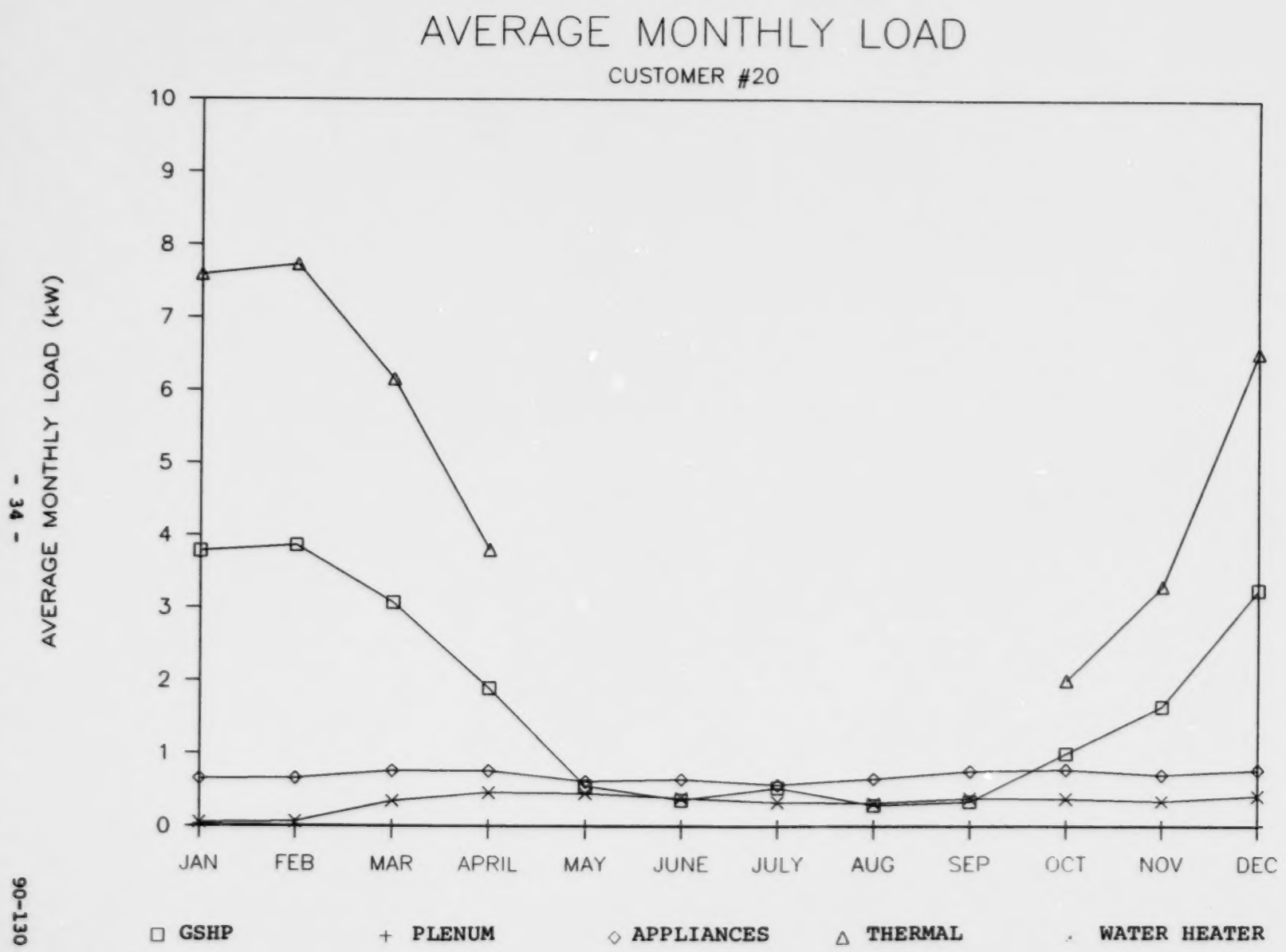

AVERAGE MONTHLY LOAD
CUSTOMER #20
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL
WATER HEATER

FIGURE A.2

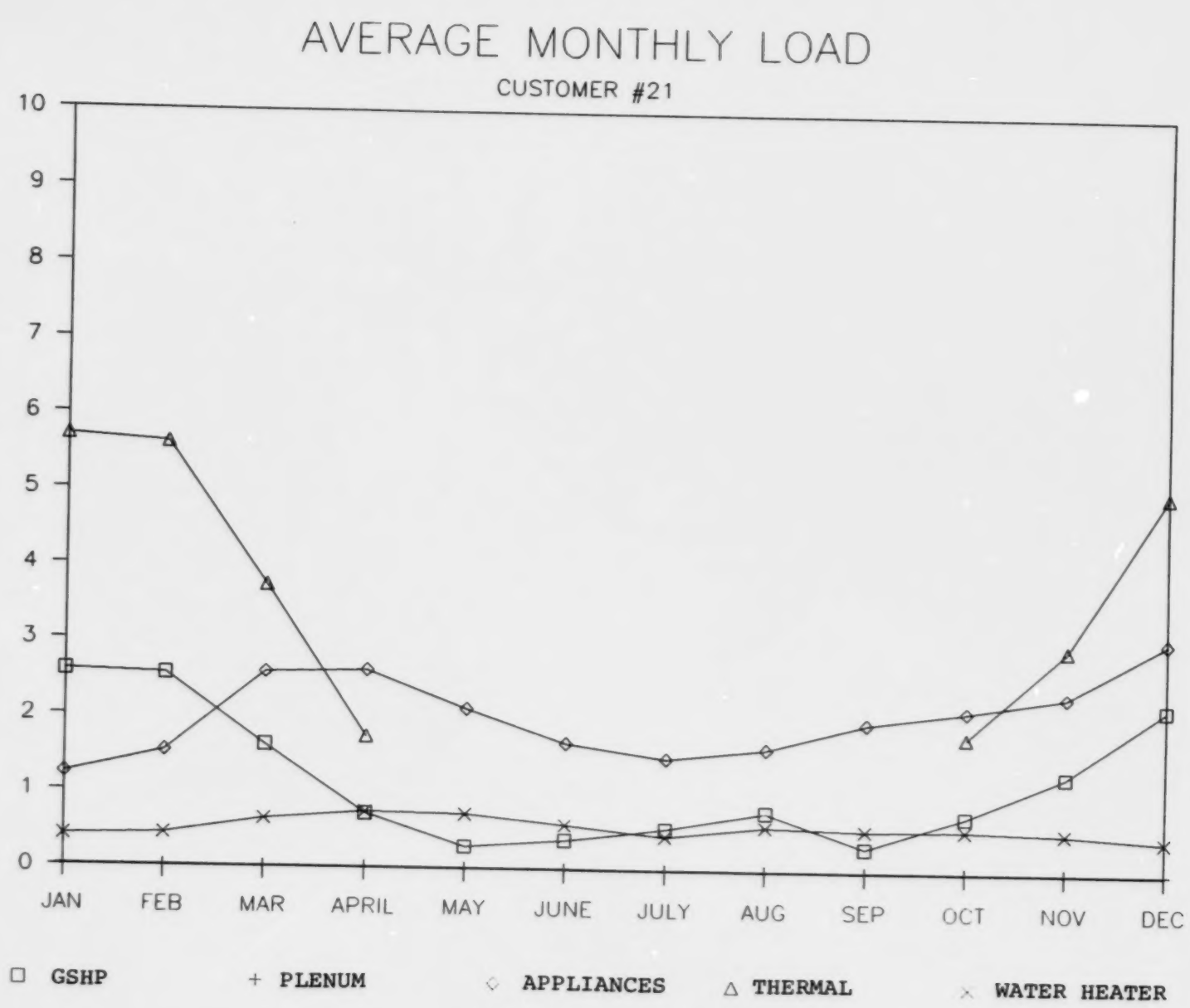

AVERAGE MONTHLY LOAD
CUSTOMER #21
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL
WATER HEATER

FIGURE A.3

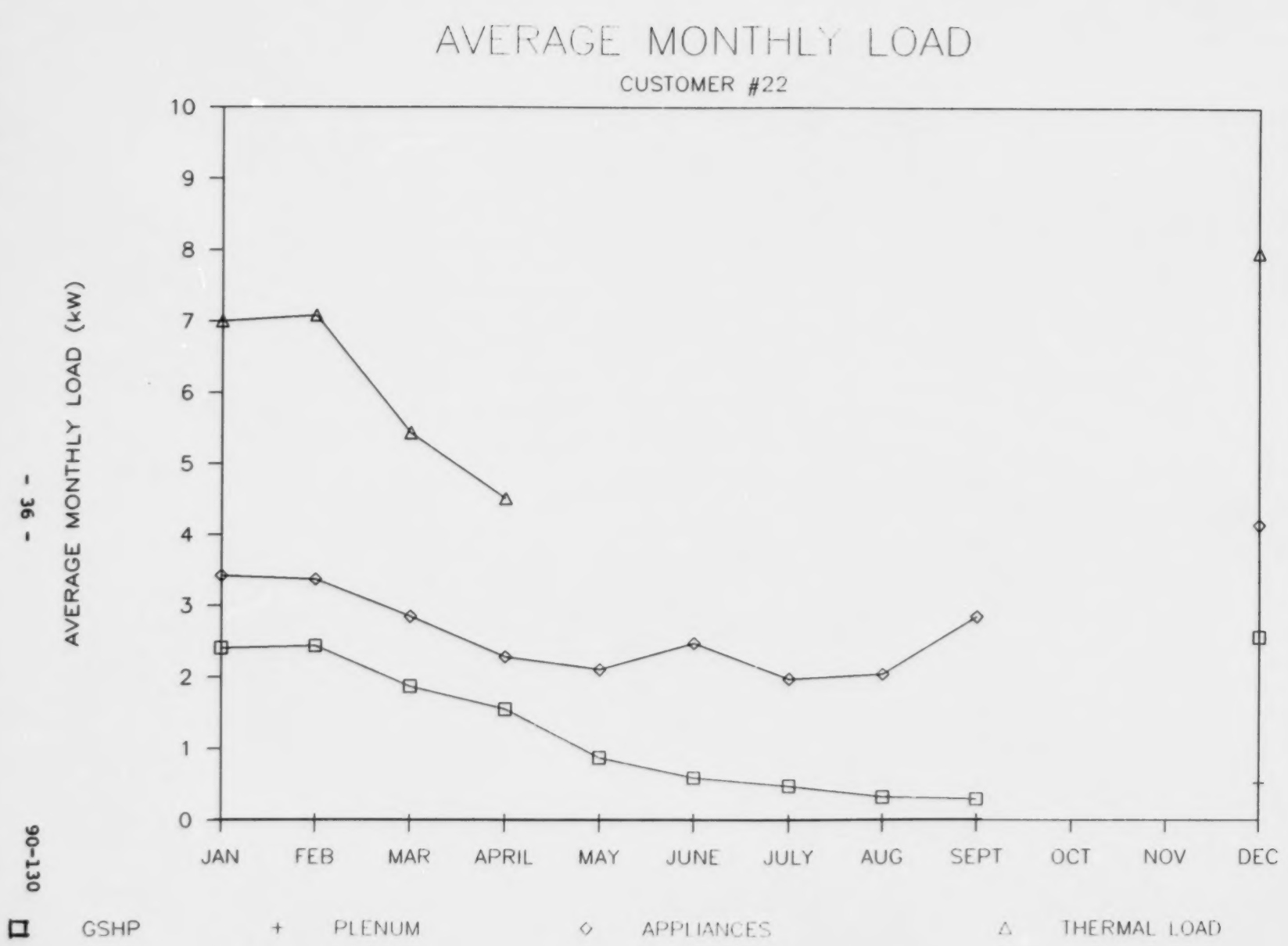

AVERAGE MONTHLY LOAD
CUSTOMER #22
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL LOAD

FIGURE A.4

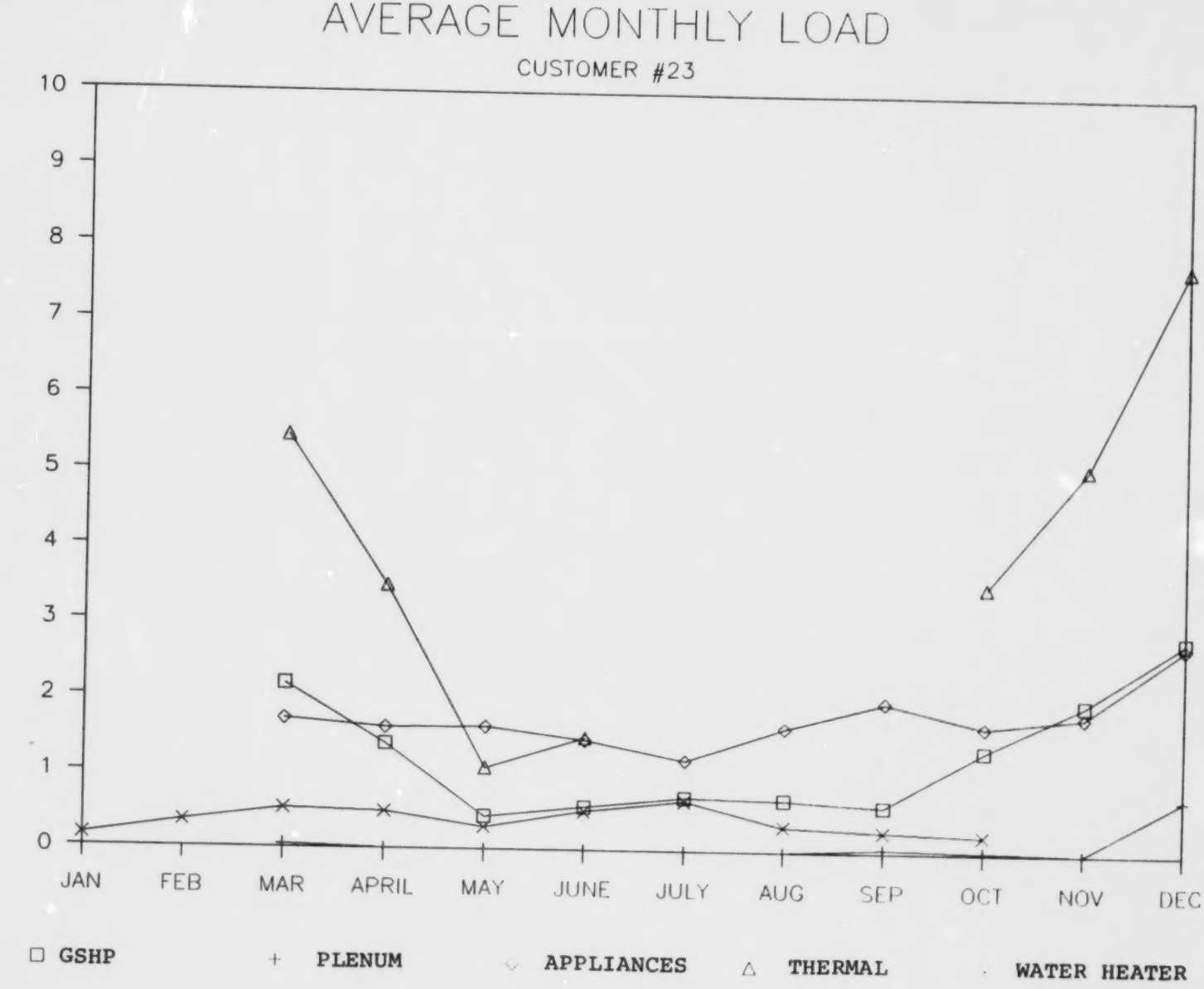

AVERAGE MONTHLY LOAD
CUSTOMER #23
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL
WATER HEATER

FIGURE A.5

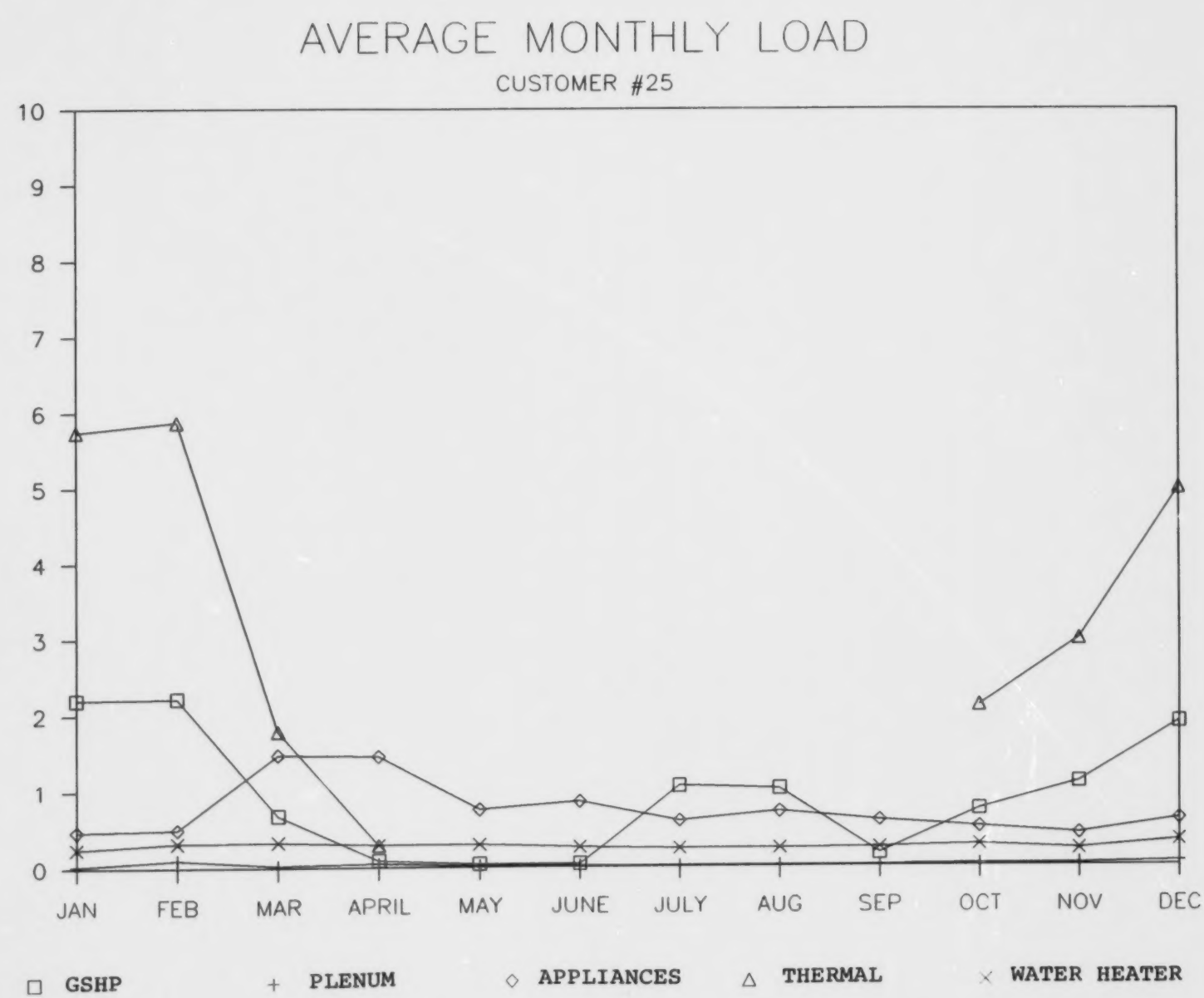

AVERAGE MONTHLY LOAD
CUSTOMER #25
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL
WATER HEATER

FIGURE A.6

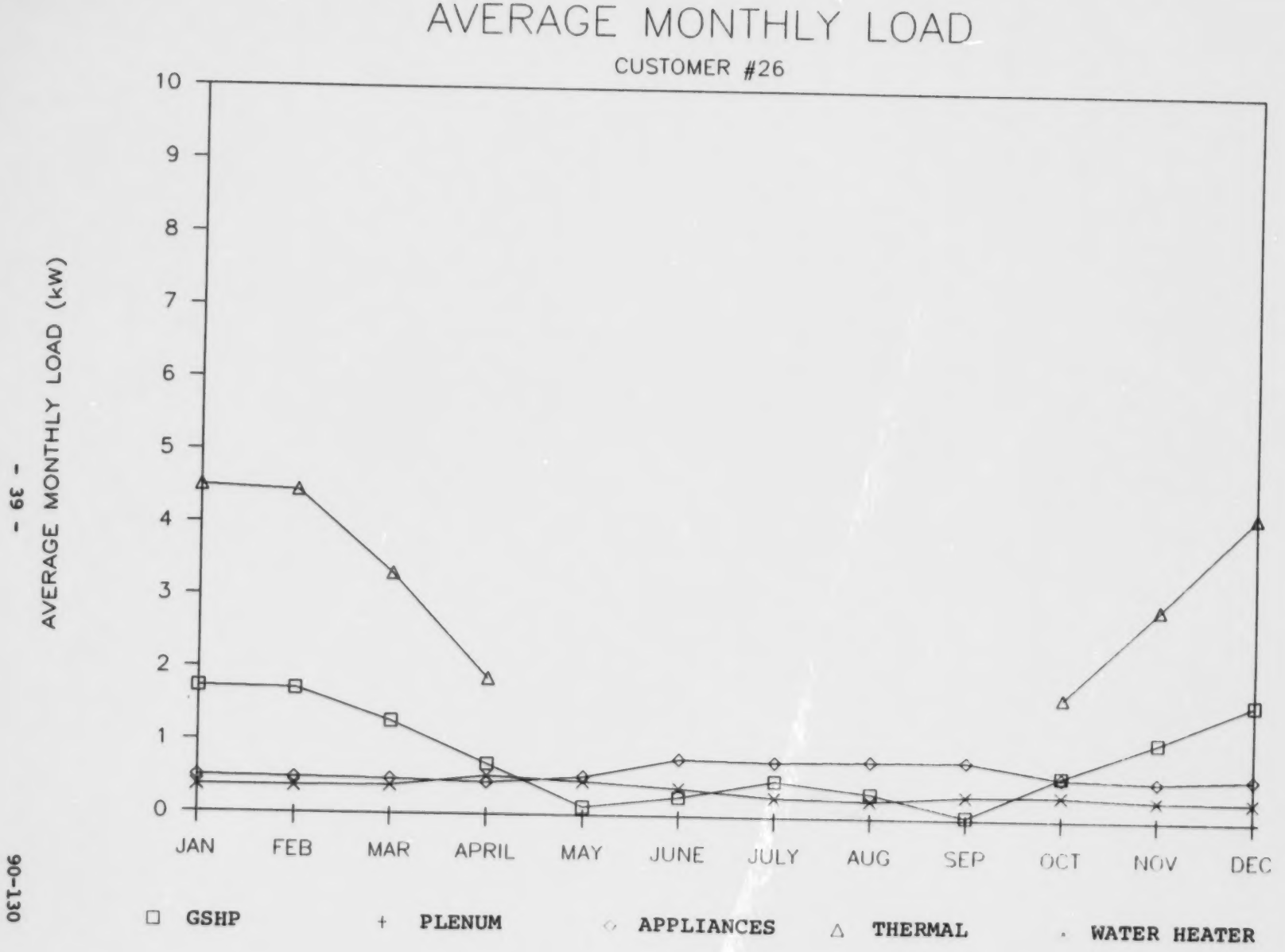

AVERAGE MONTHLY LOAD
CUSTOMER #26
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL
WATER HEATER

FIGURE A.7

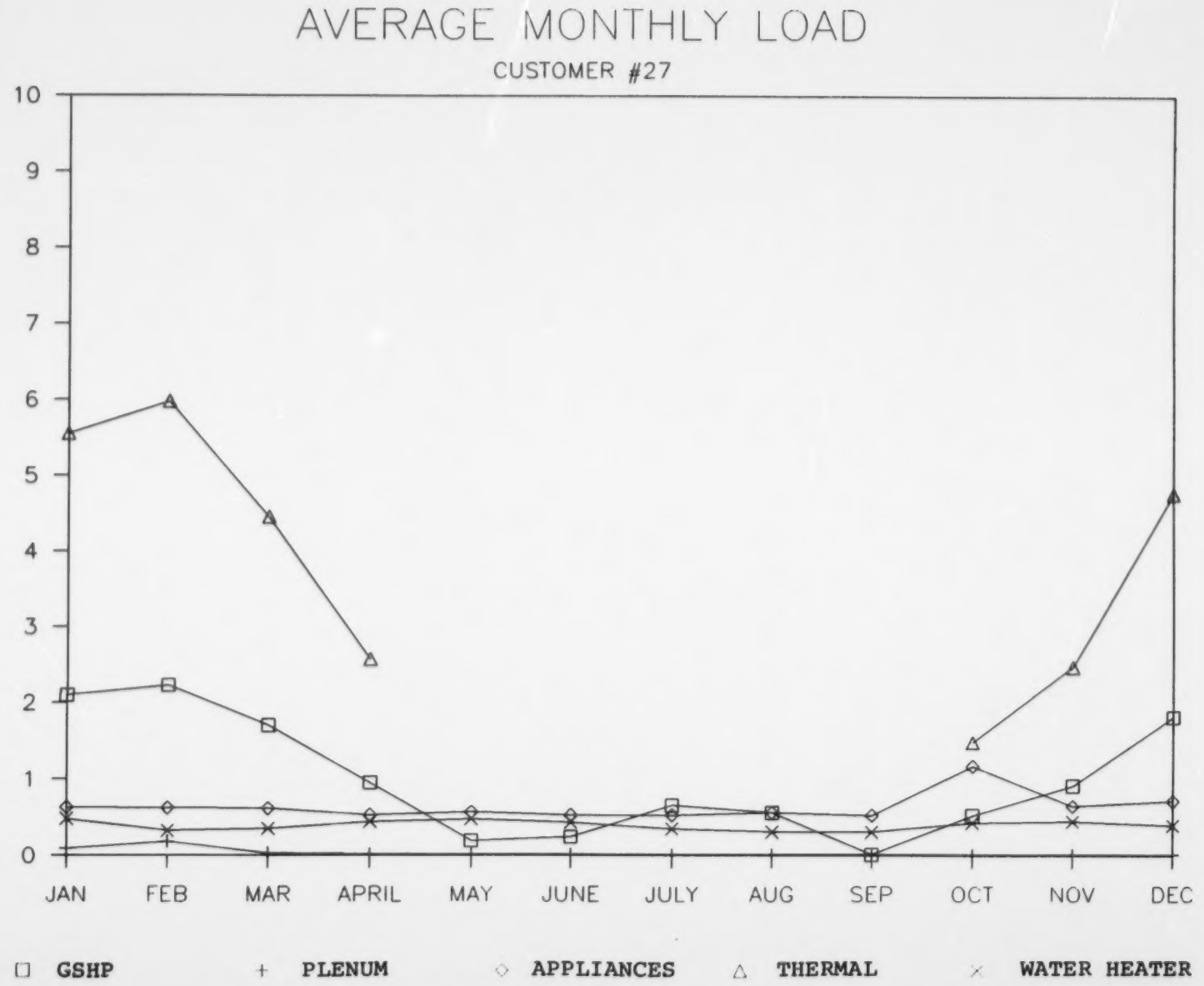

AVERAGE MONTHLY LOAD
CUSTOMER #27
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL
WATER HEATER

FIGURE A.8

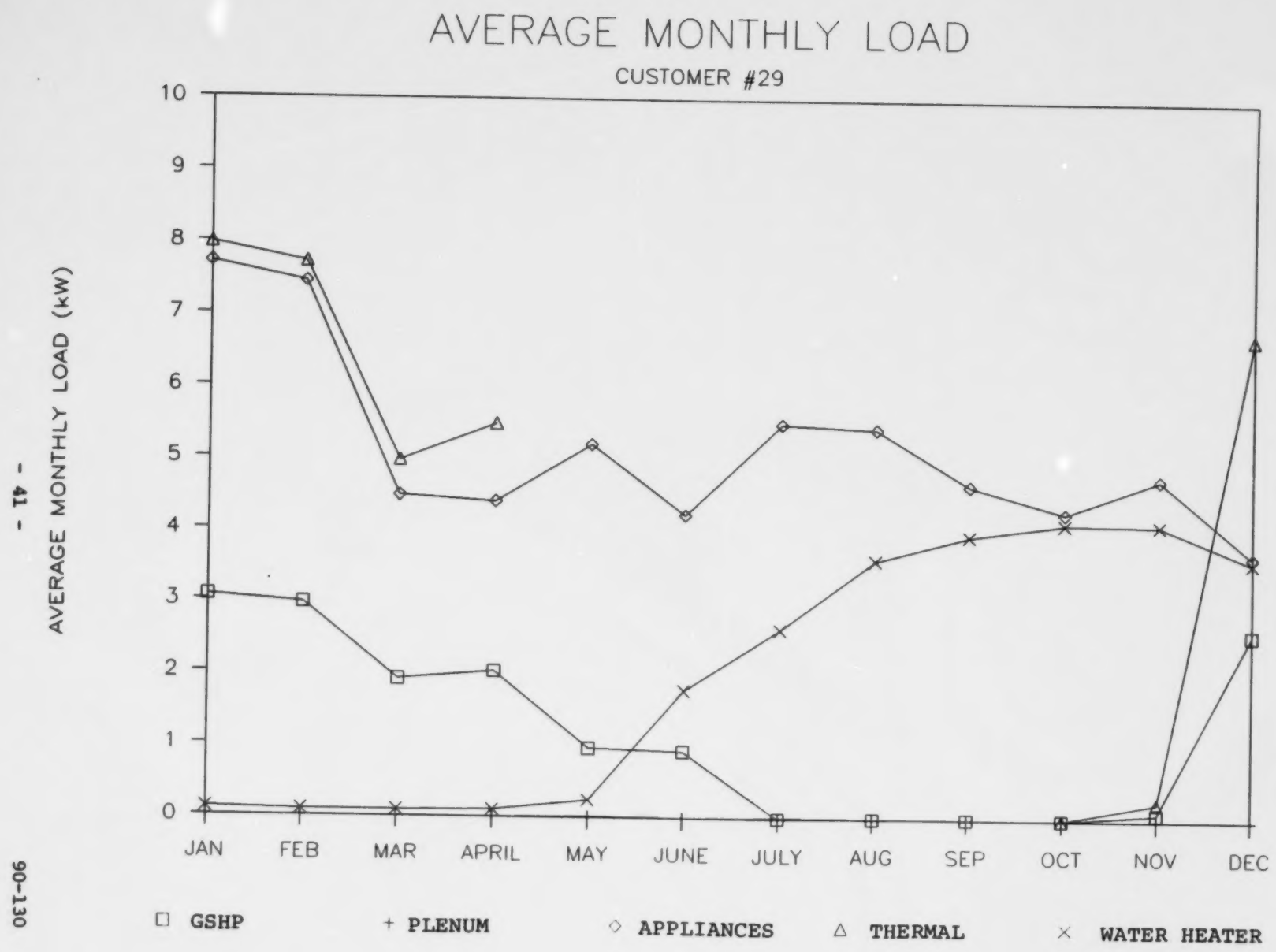

AVERAGE MONTHLY LOAD
CUSTOMER #29
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL
WATER HEATER

FIGURE A.9

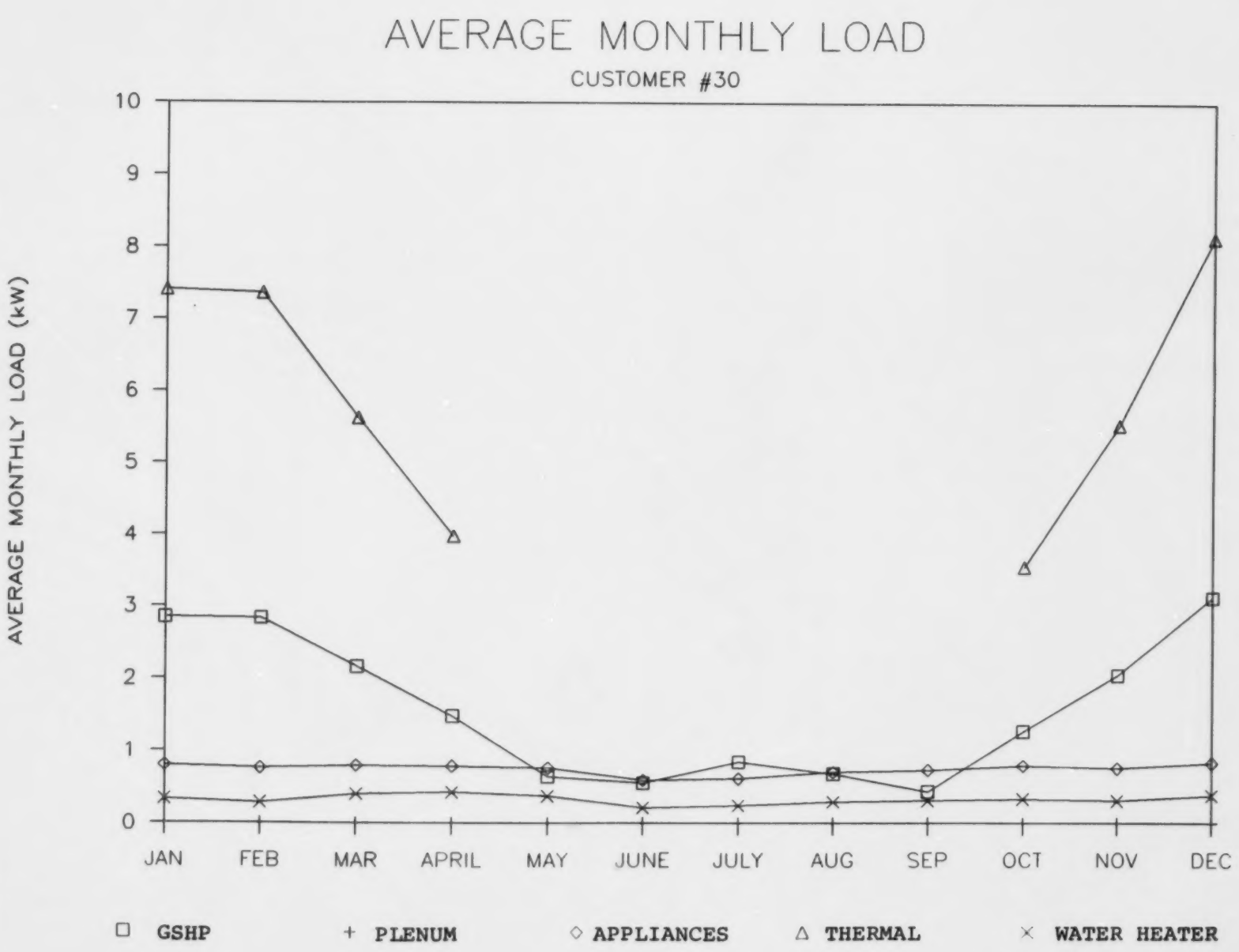

AVERAGE MONTHLY LOAD
CUSTOMER #30
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL
WATER HEATER

FIGURE A.10

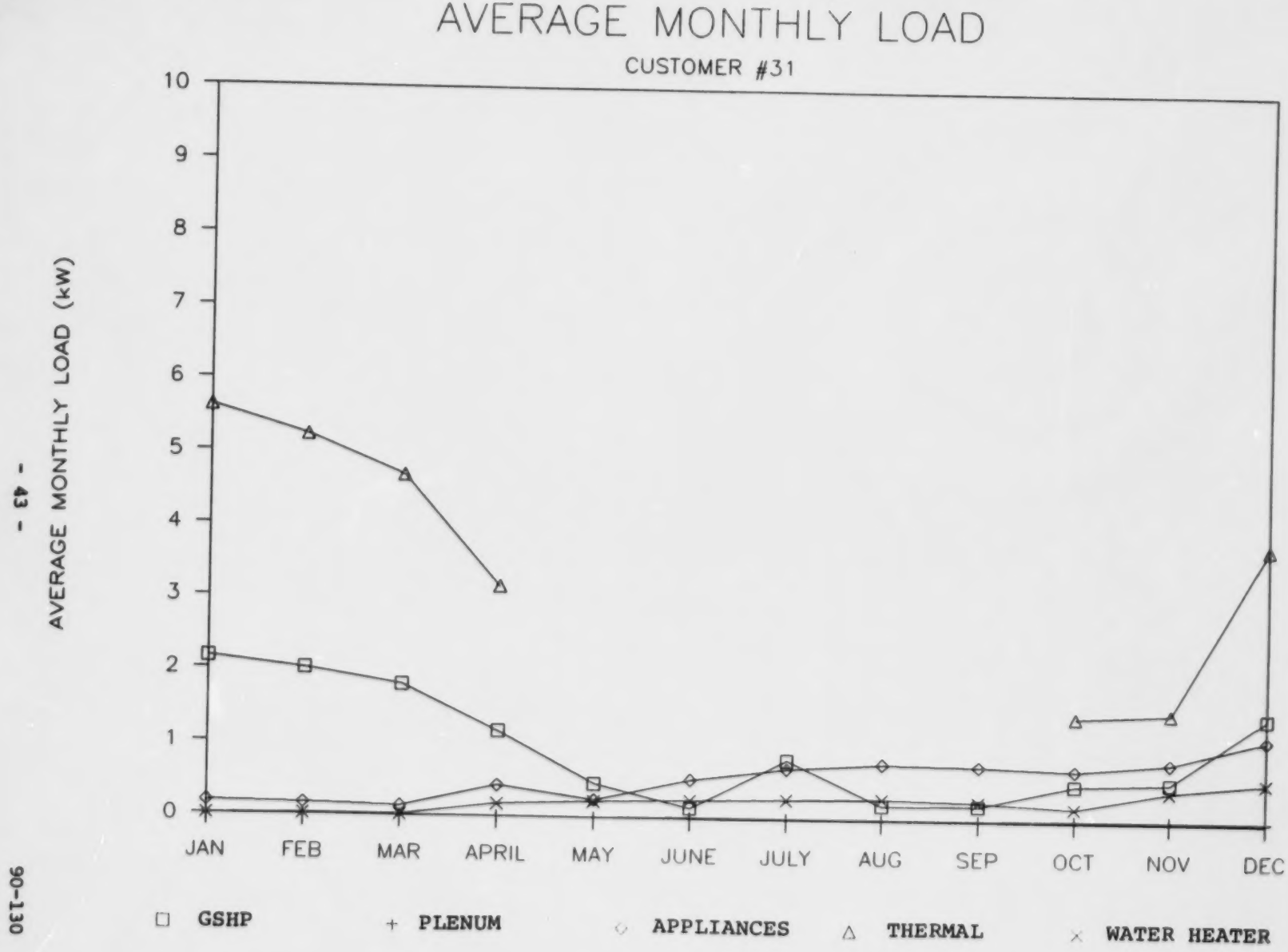

AVERAGE MONTHLY LOAD
CUSTOMER #31
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL
WATER HEATER

FIGURE A.11

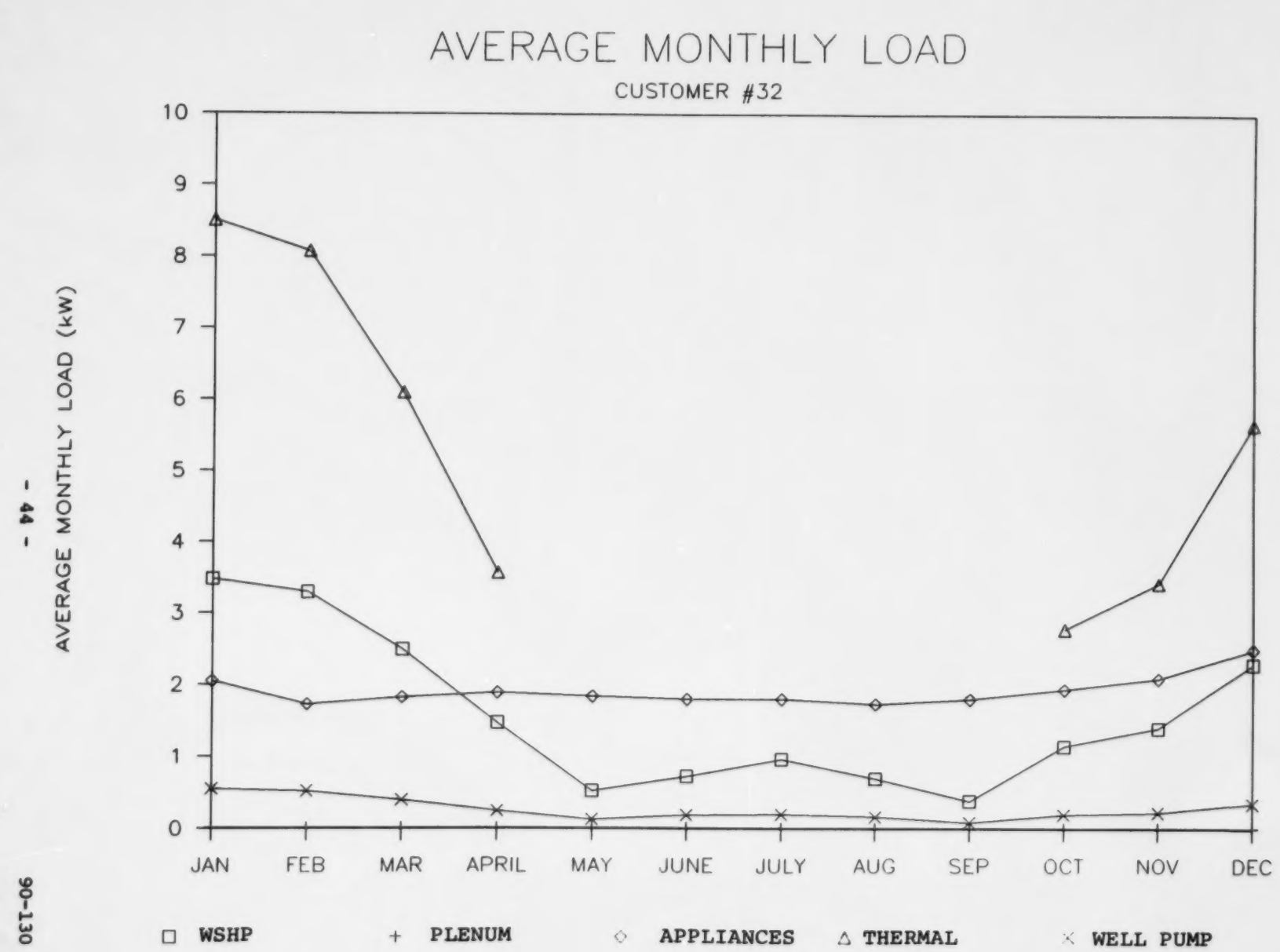

AVERAGE MONTHLY LOAD
CUSTOMER #32
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
WSHP
PLENUM
APPLIANCES
THERMAL
WELL PUMP

FIGURE A.12

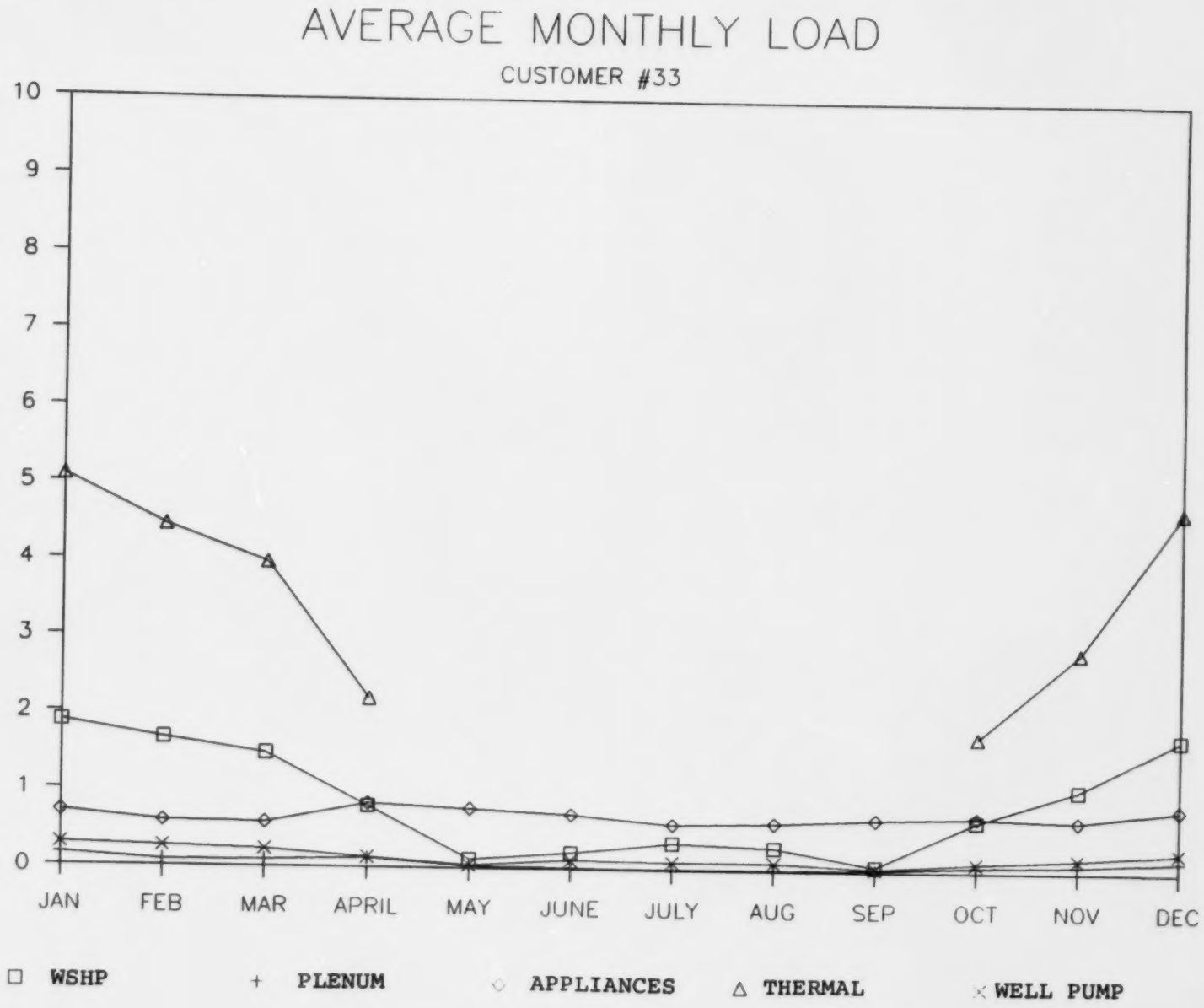

AVERAGE MONTHLY LOAD
CUSTOMER #33
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
WSHP
PLENUM
APPLIANCES
THERMAL
WELL PUMP

FIGURE A.13

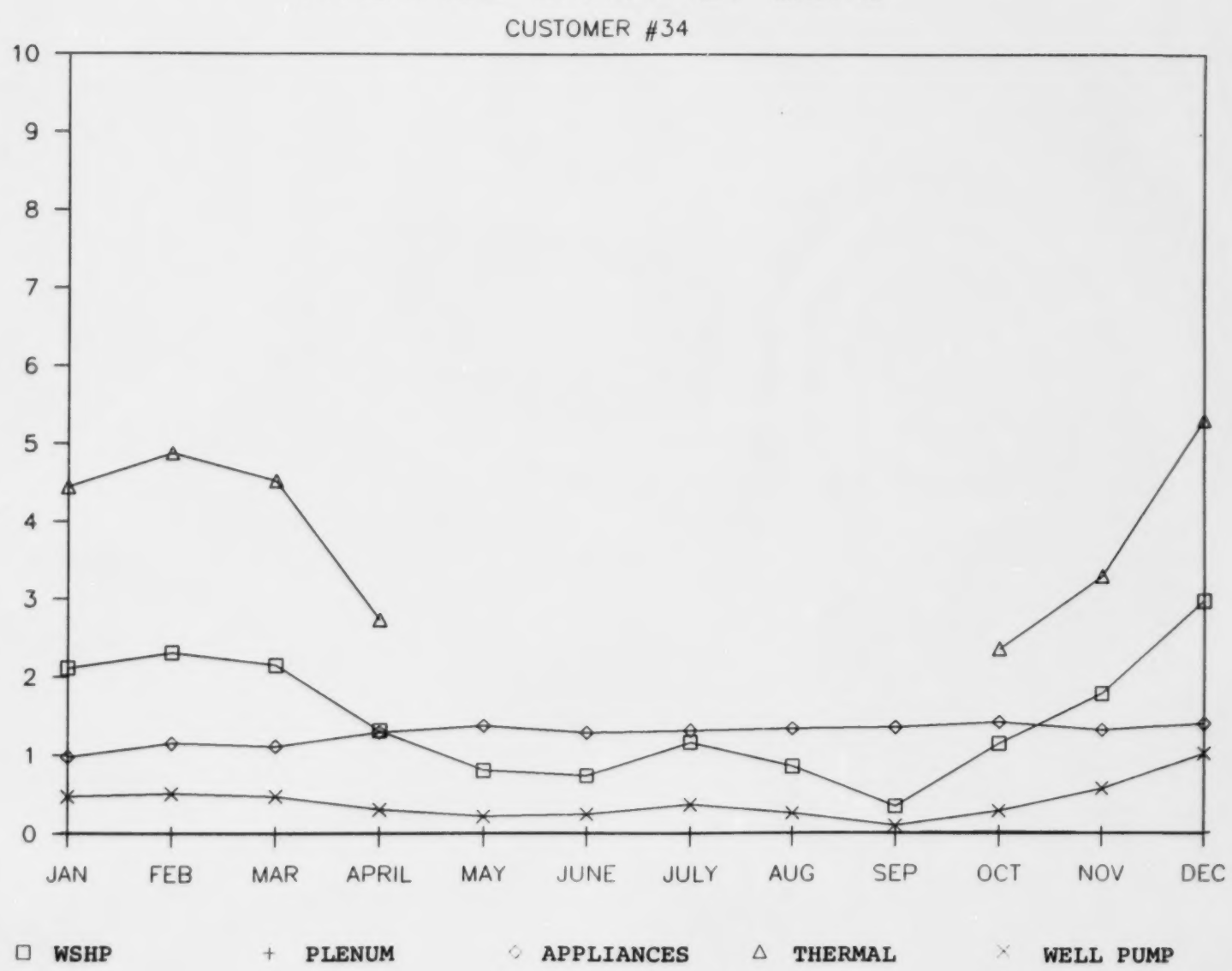

AVERAGE MONTHLY LOAD
CUSTOMER #34
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
WSHP
PLENUM
APPLIANCES
THERMAL
WELL PUMP

FIGURE A.14

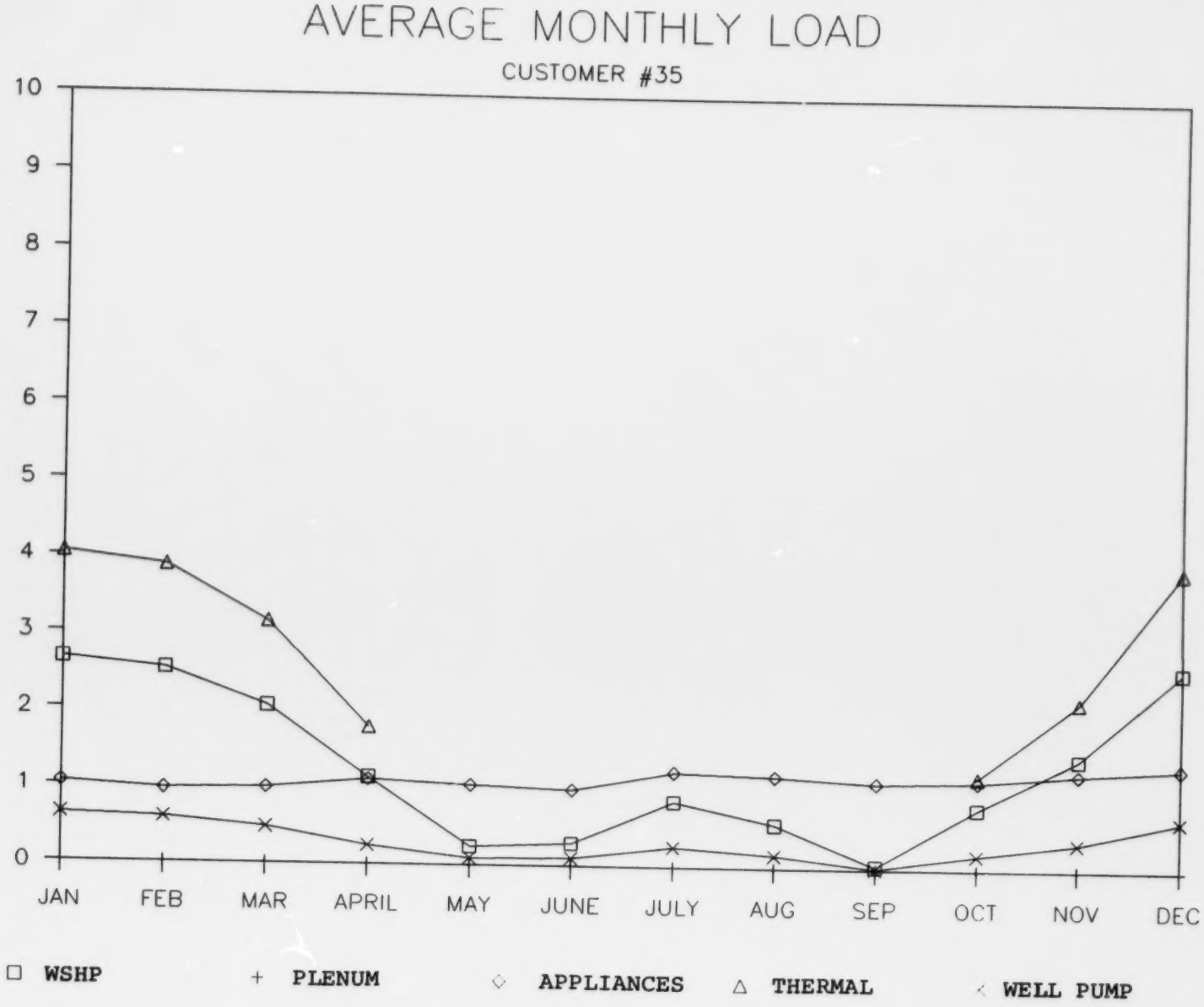

AVERAGE MONTHLY LOAD
CUSTOMER #35
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
WSHP
PLENUM
APPLIANCES
THERMAL
WELL PUMP

FIGURE A.15

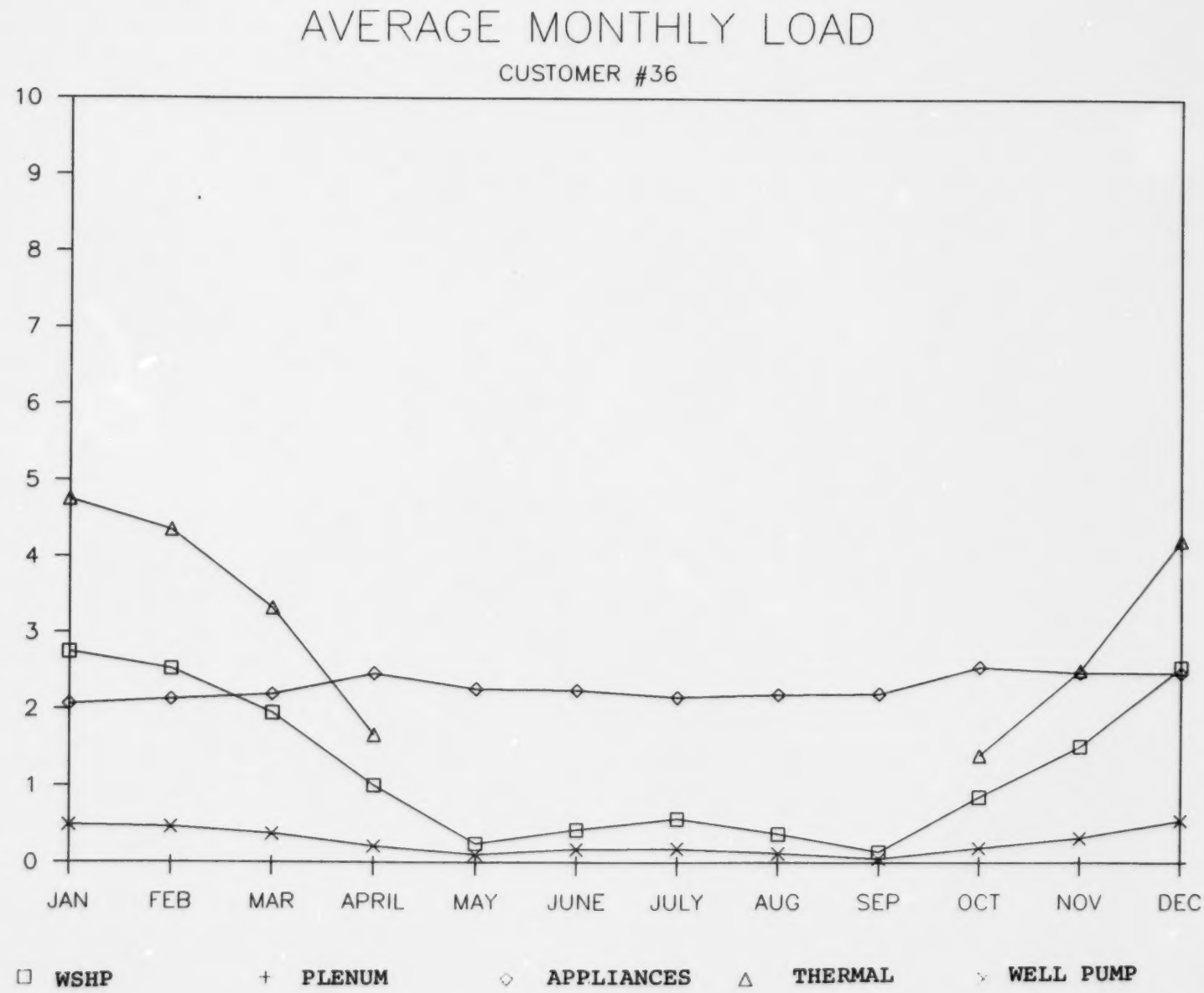

AVERAGE MONTHLY LOAD
CUSTOMER #36
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
WSHP
PLENUM
APPLIANCES
THERMAL
WELL PUMP

FIGURE A.16

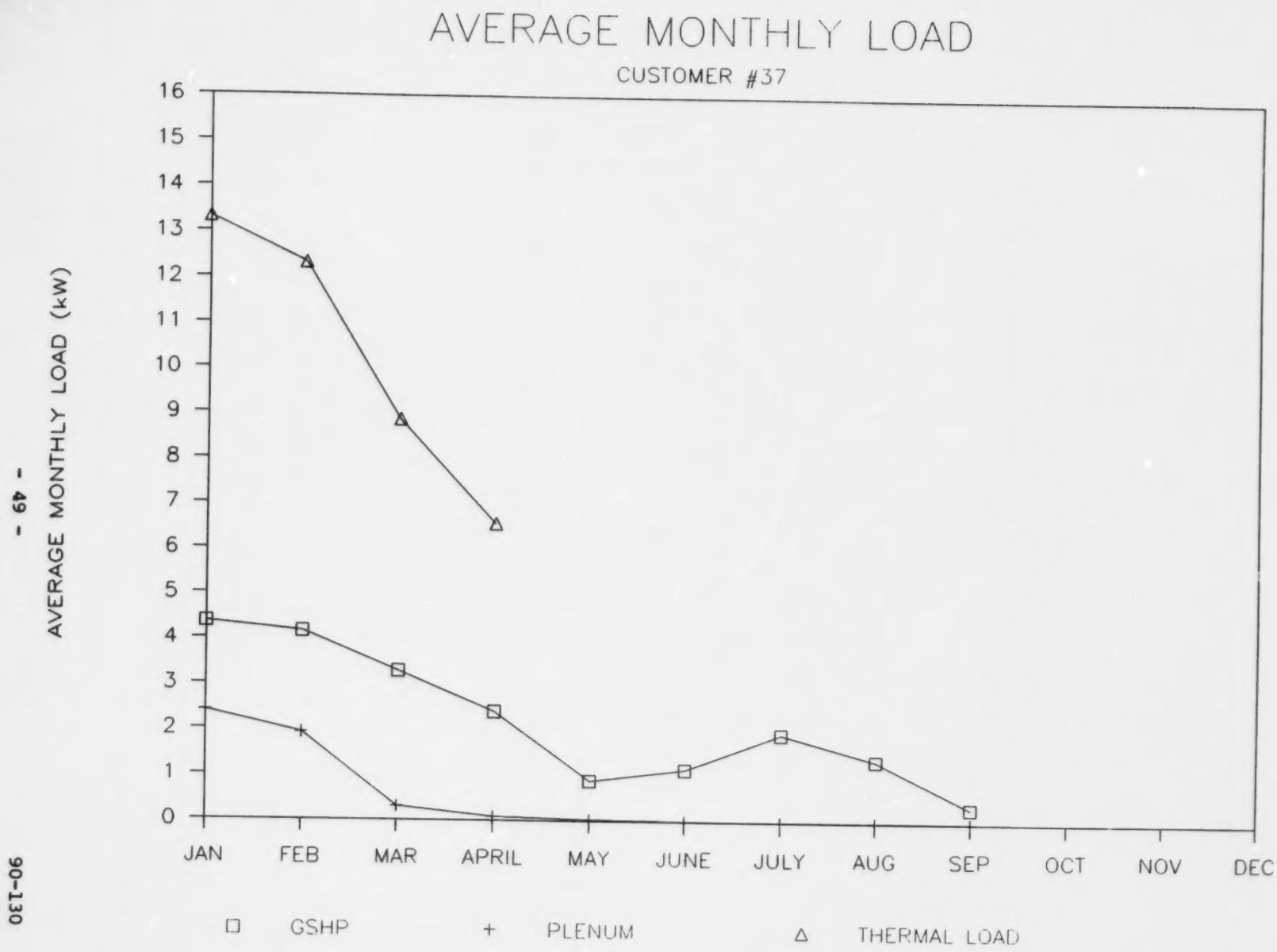

AVERAGE MONTHLY LOAD
CUSTOMER #37
AVERAGE MONTHLY LOAD (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
□ GSHP
+ PLENUM
△ THERMAL LOAD

FIGURE A.17

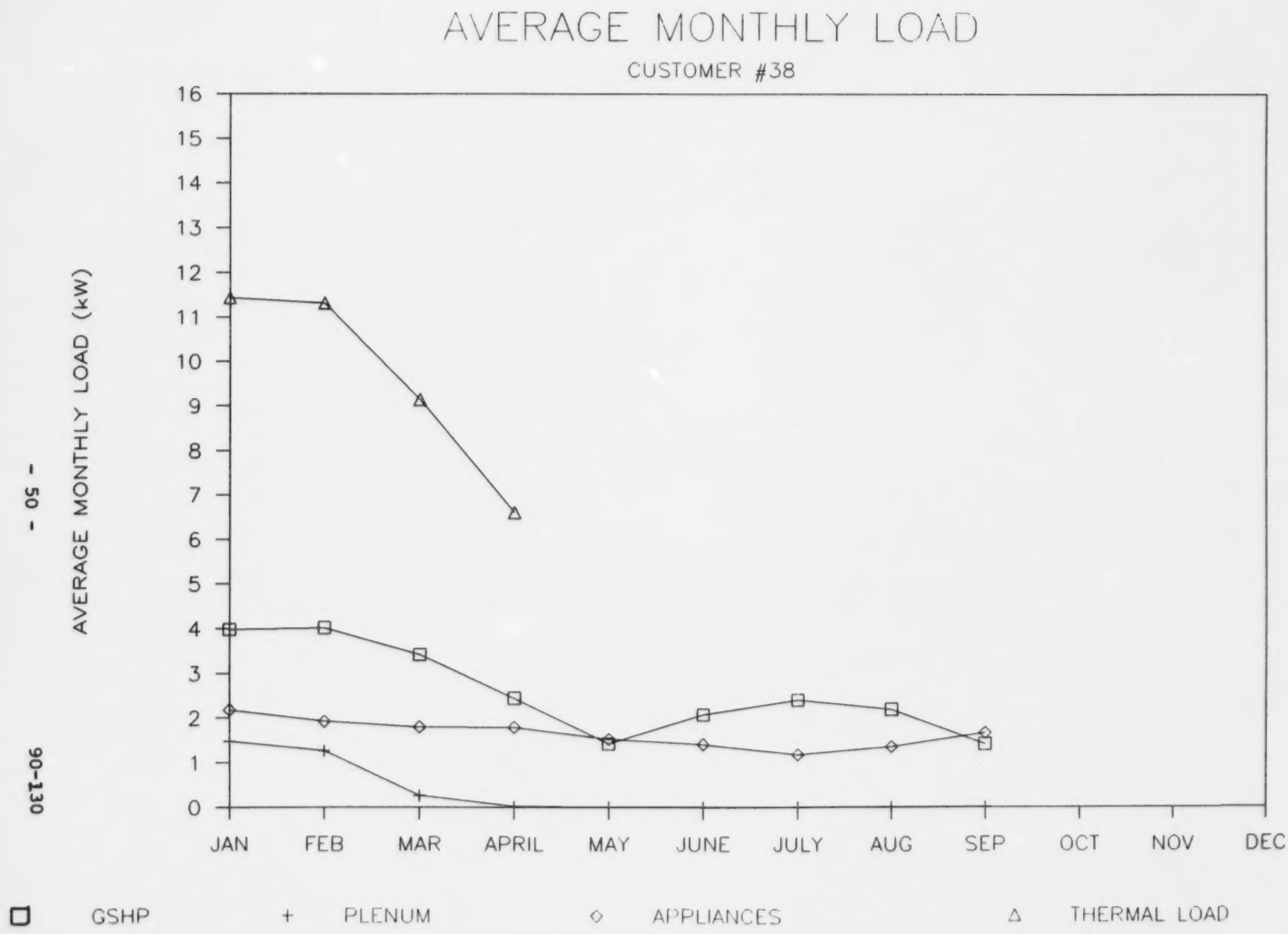
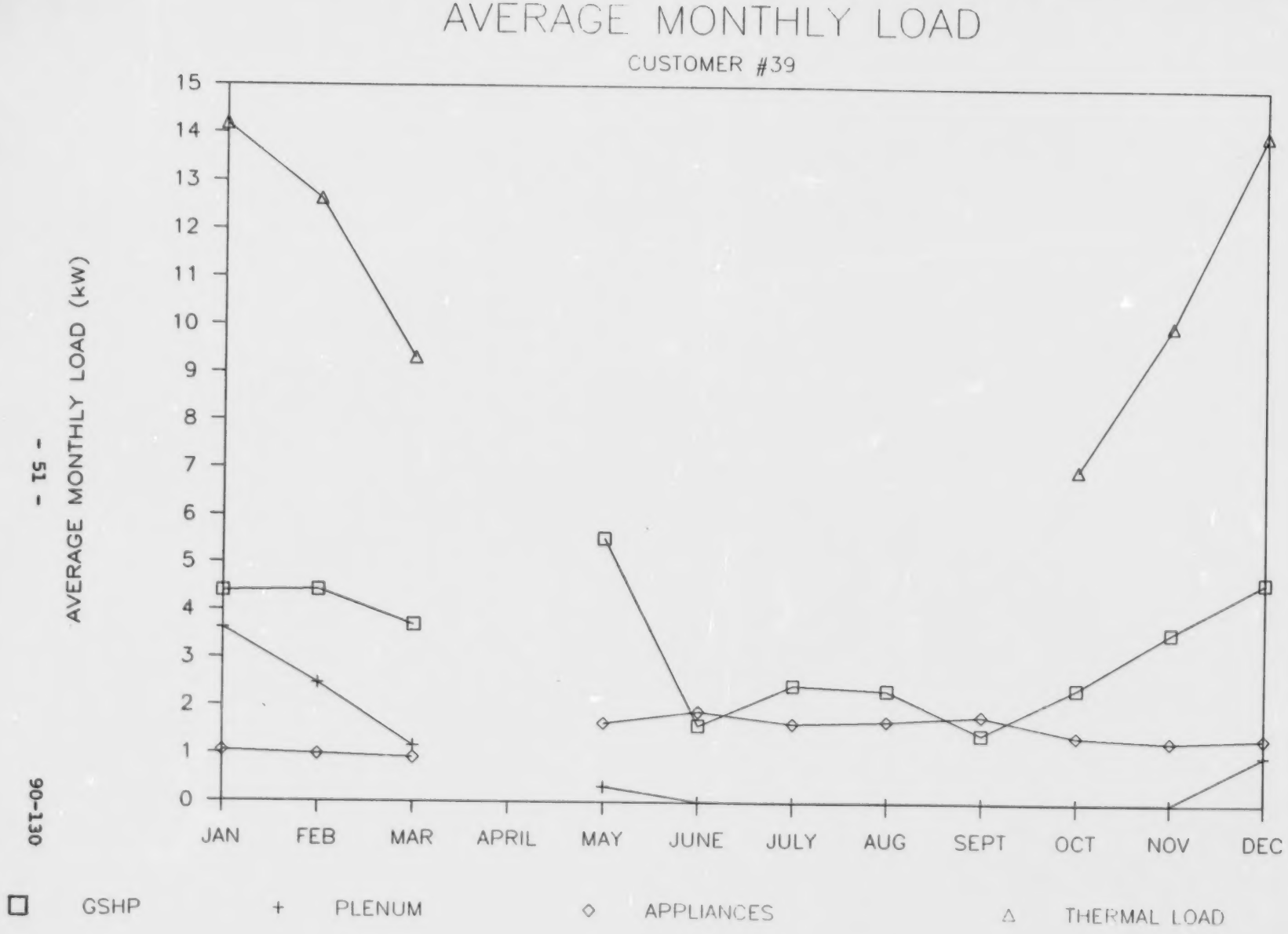

AVERAGE MONTHLY LOAD
CUSTOMER #38
AVERAGE MONTHLY LOAD (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL LOAD

FIGURE A.18



90-130

FIGURE A.19

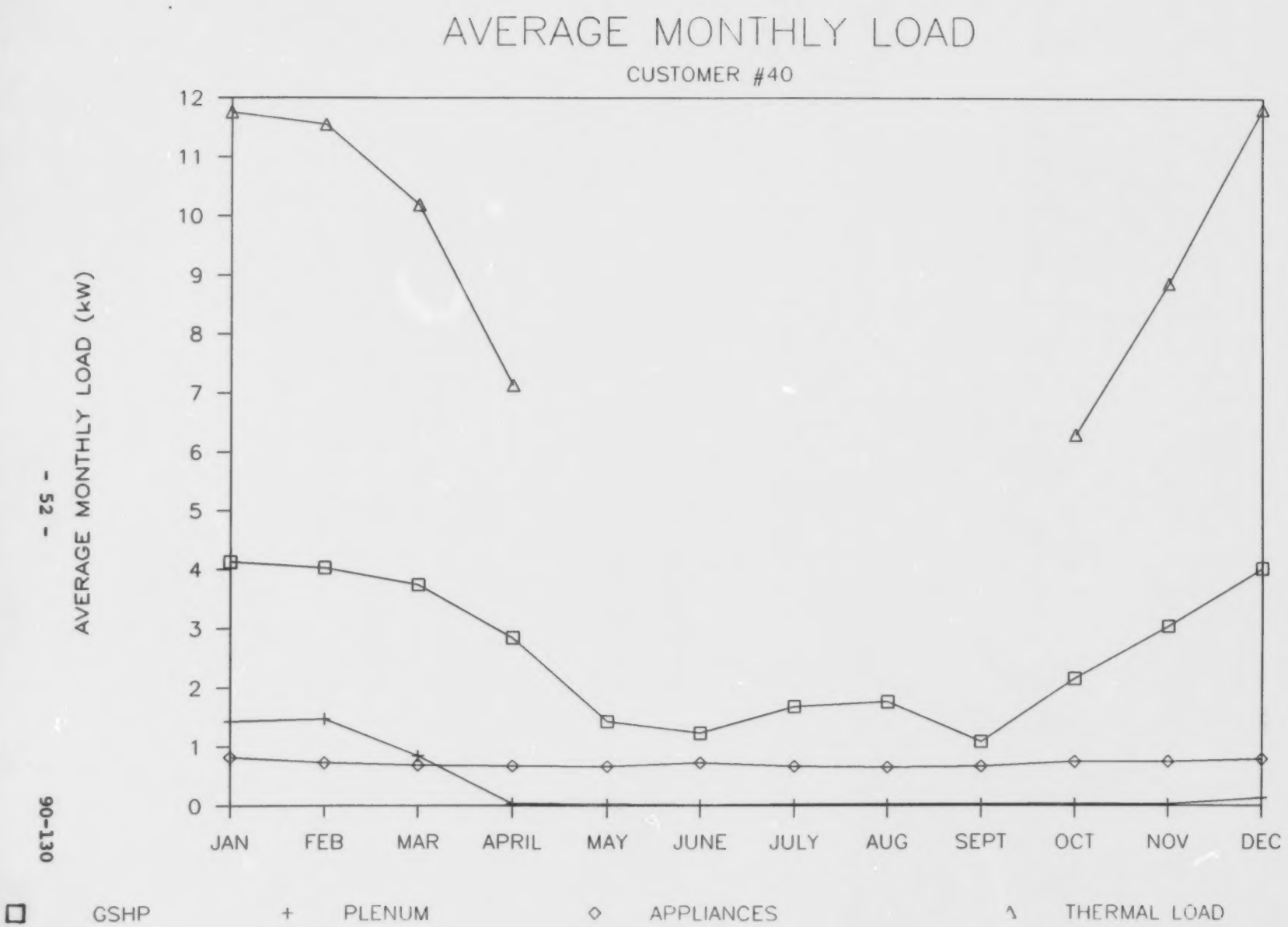
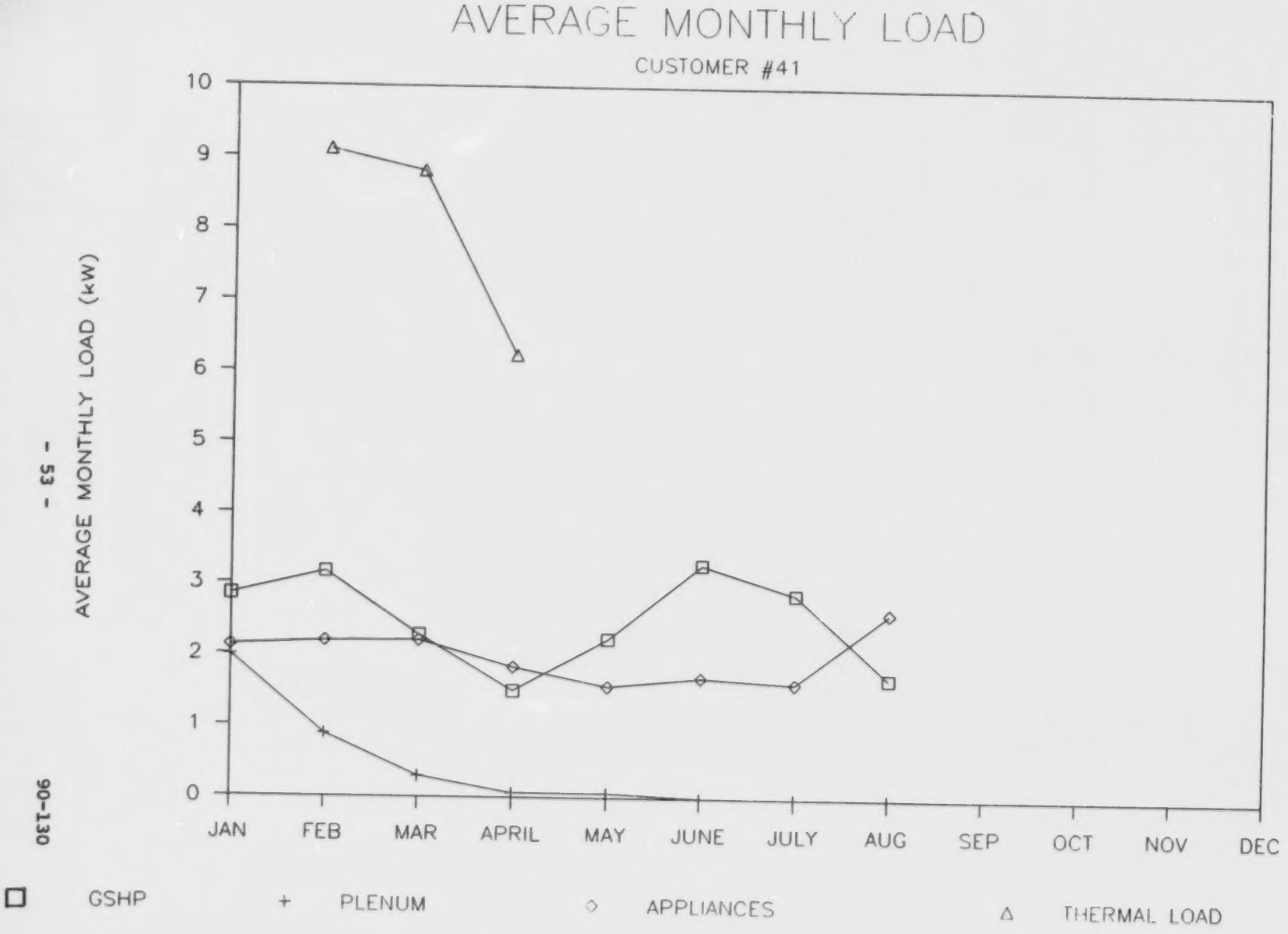

AVERAGE MONTHLY LOAD
CUSTOMER #40
AVERAGE MONTHLY LOAD (kW)
0
1
2
3
4
5
6
7
8
9
10
11
12
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL LOAD

FIGURE A.20



90-130

FIGURE A.21

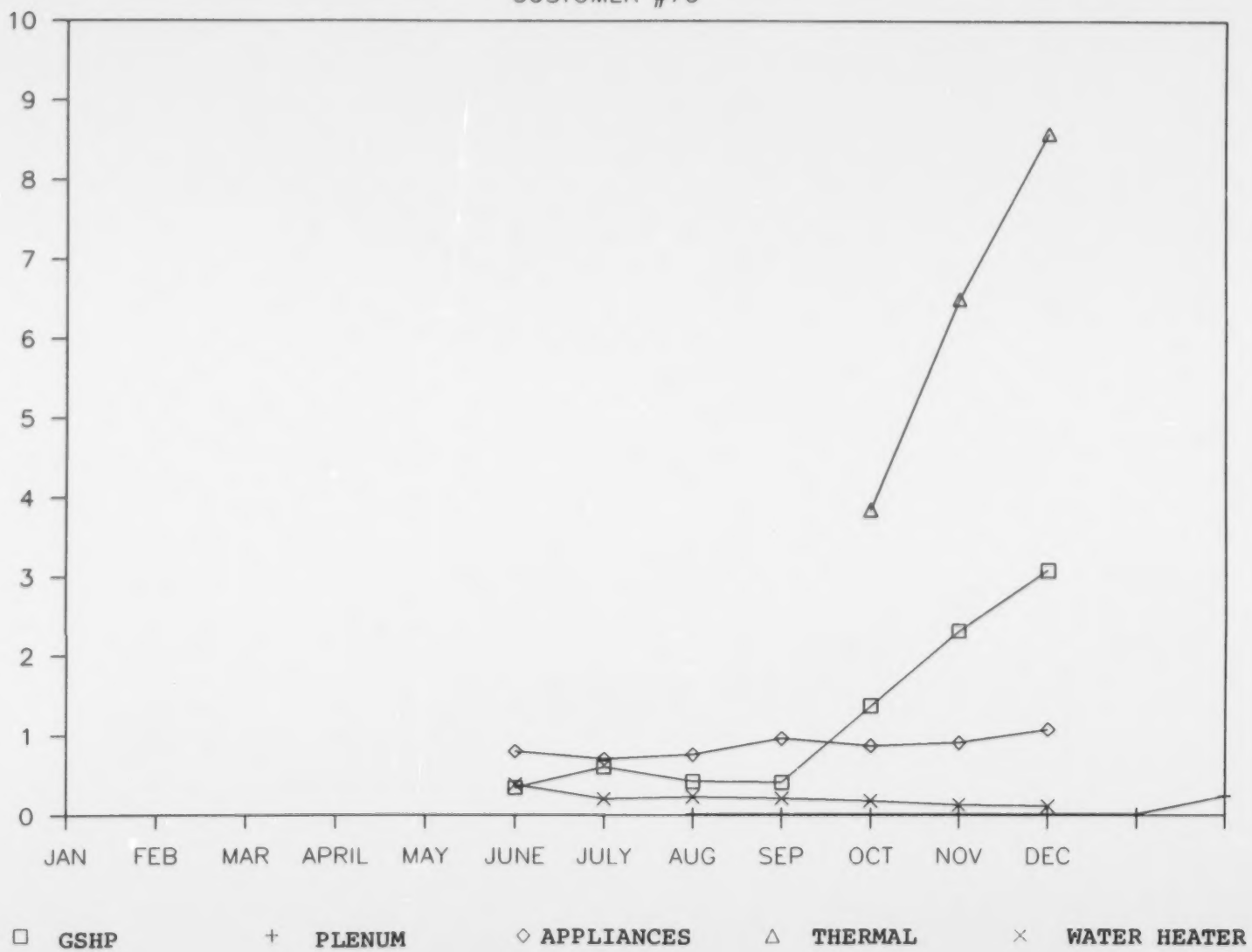

AVERAGE MONTHLY LOAD
CUSTOMER #76
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL
WATER HEATER

FIGURE A.22

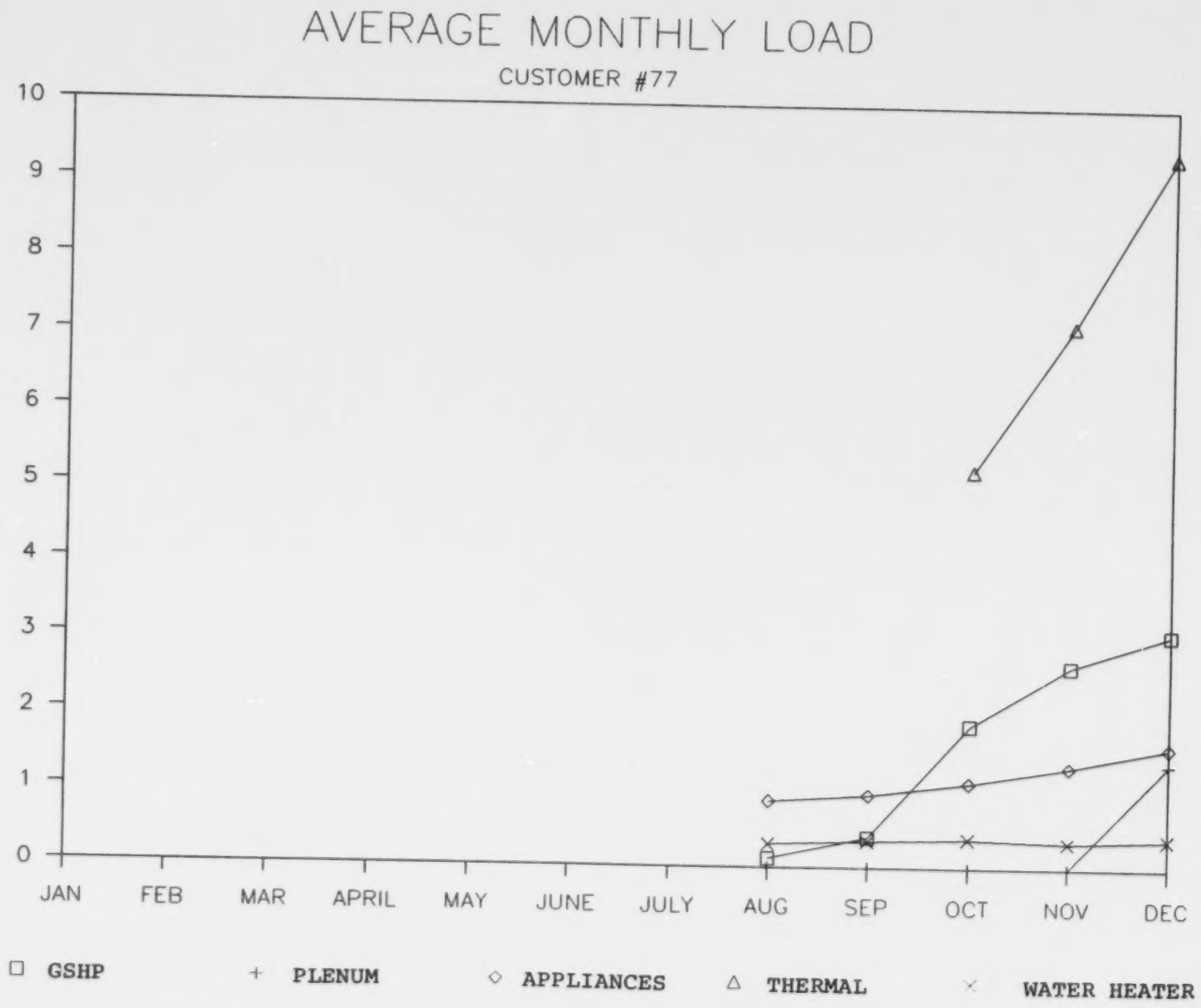

AVERAGE MONTHLY LOAD
CUSTOMER #77
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL
WATER HEATER

FIGURE A.23

AVERAGE MONTHLY LOAD

CUSTOMER #78

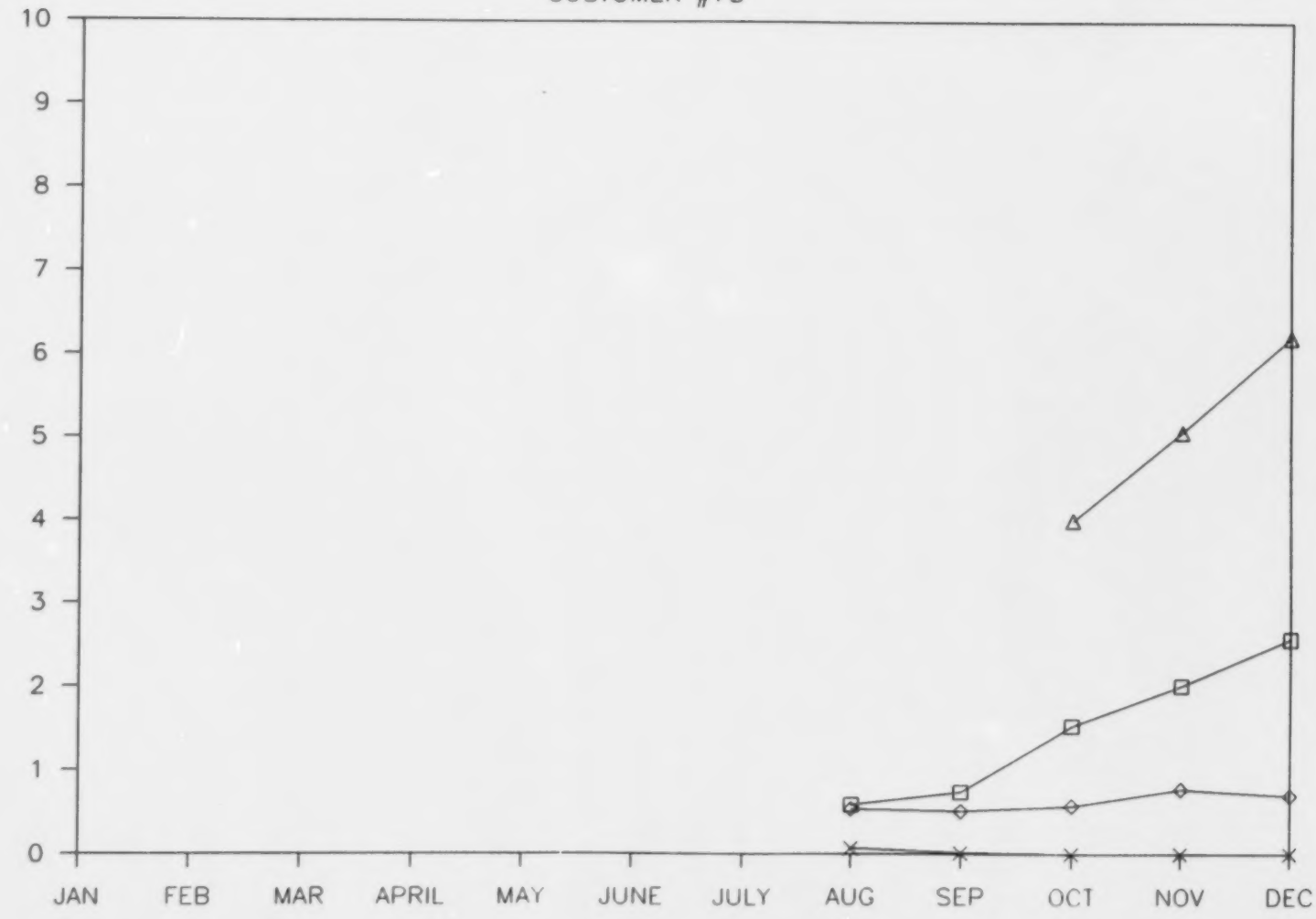


FIGURE A.24

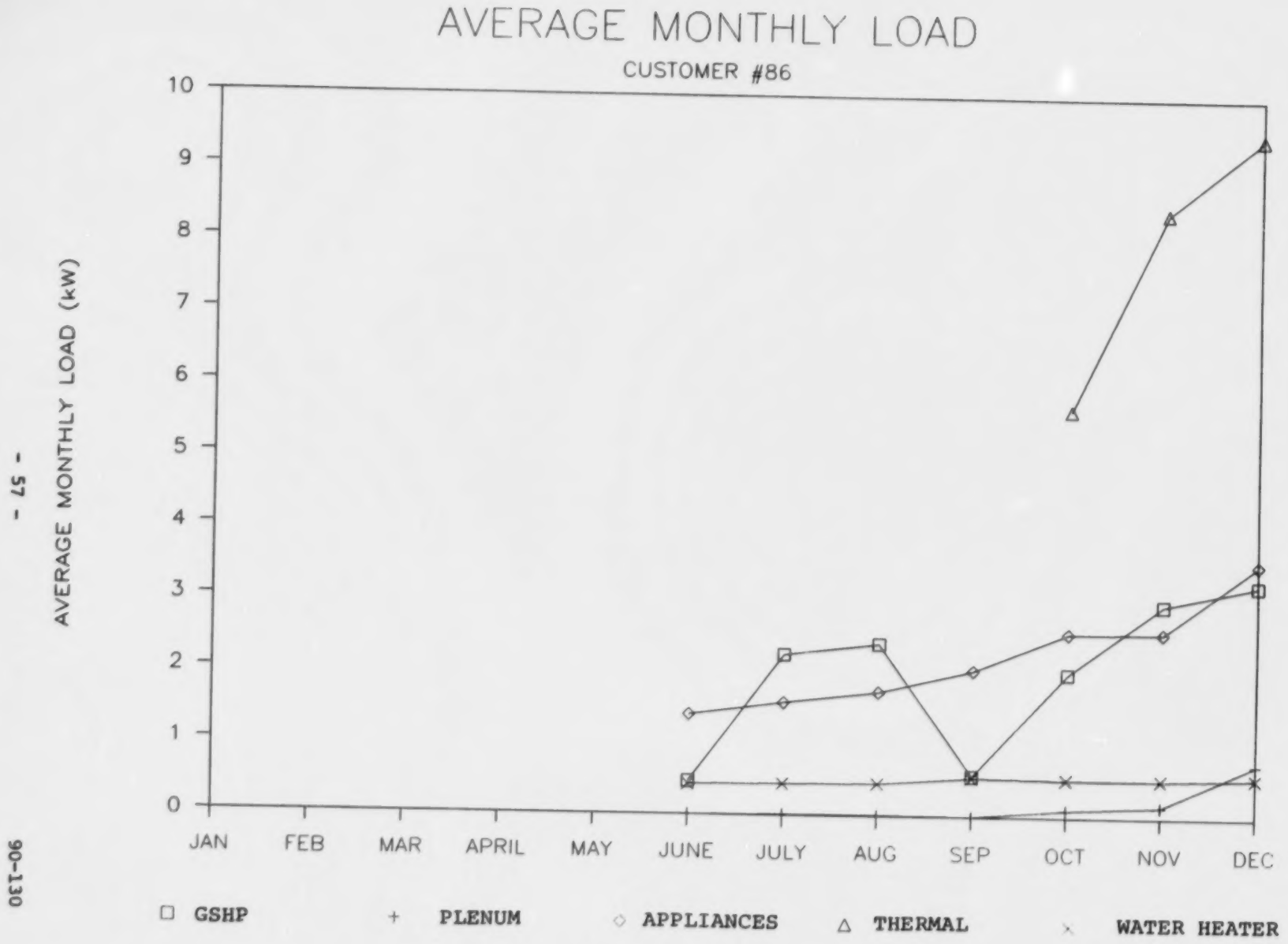
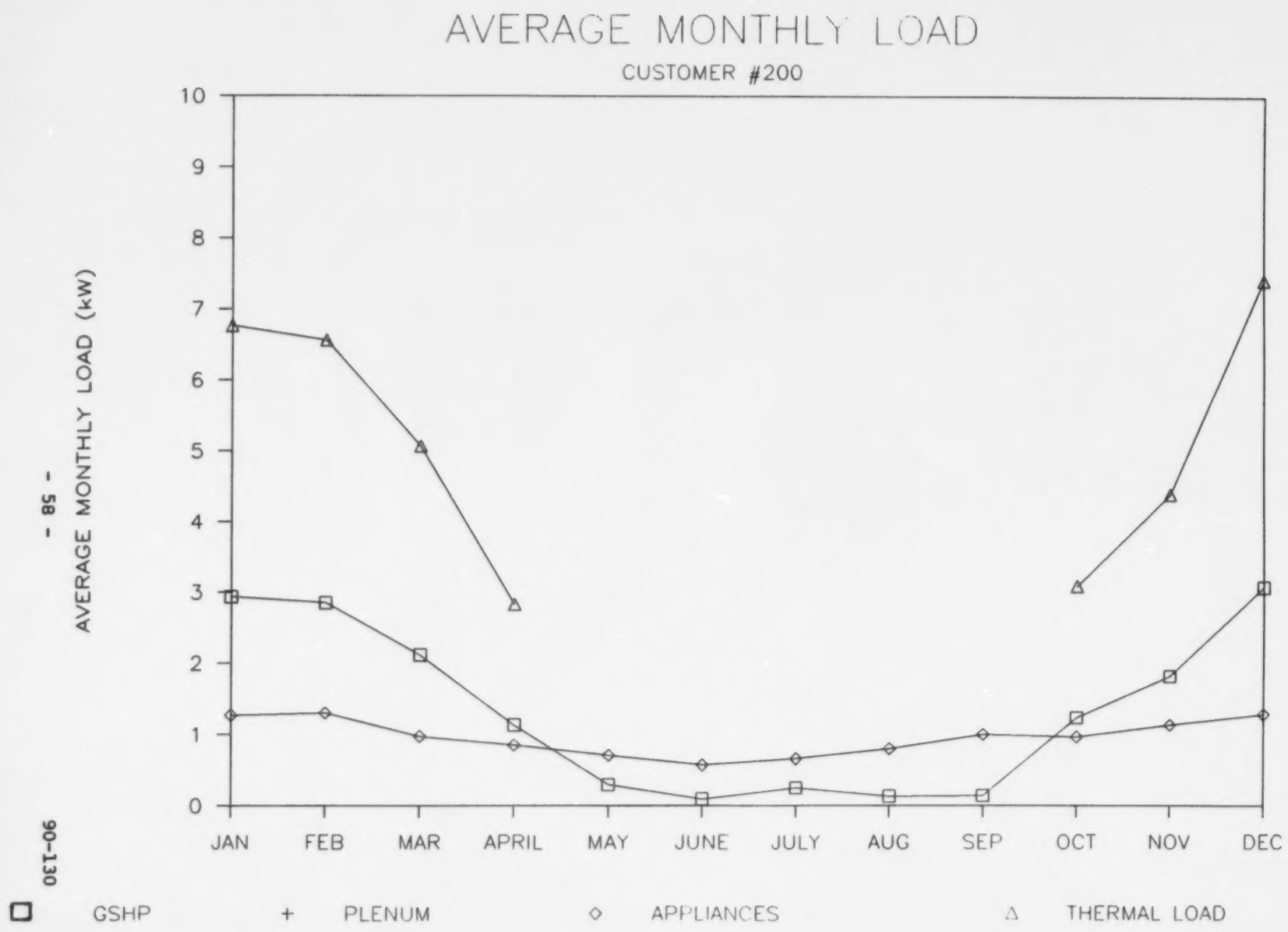

AVERAGE MONTHLY LOAD
CUSTOMER #86
AVERAGE MONTHLY LOAD (kW)
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL
WATER HEATER

FIGURE A.25



90-130

FIGURE A.26

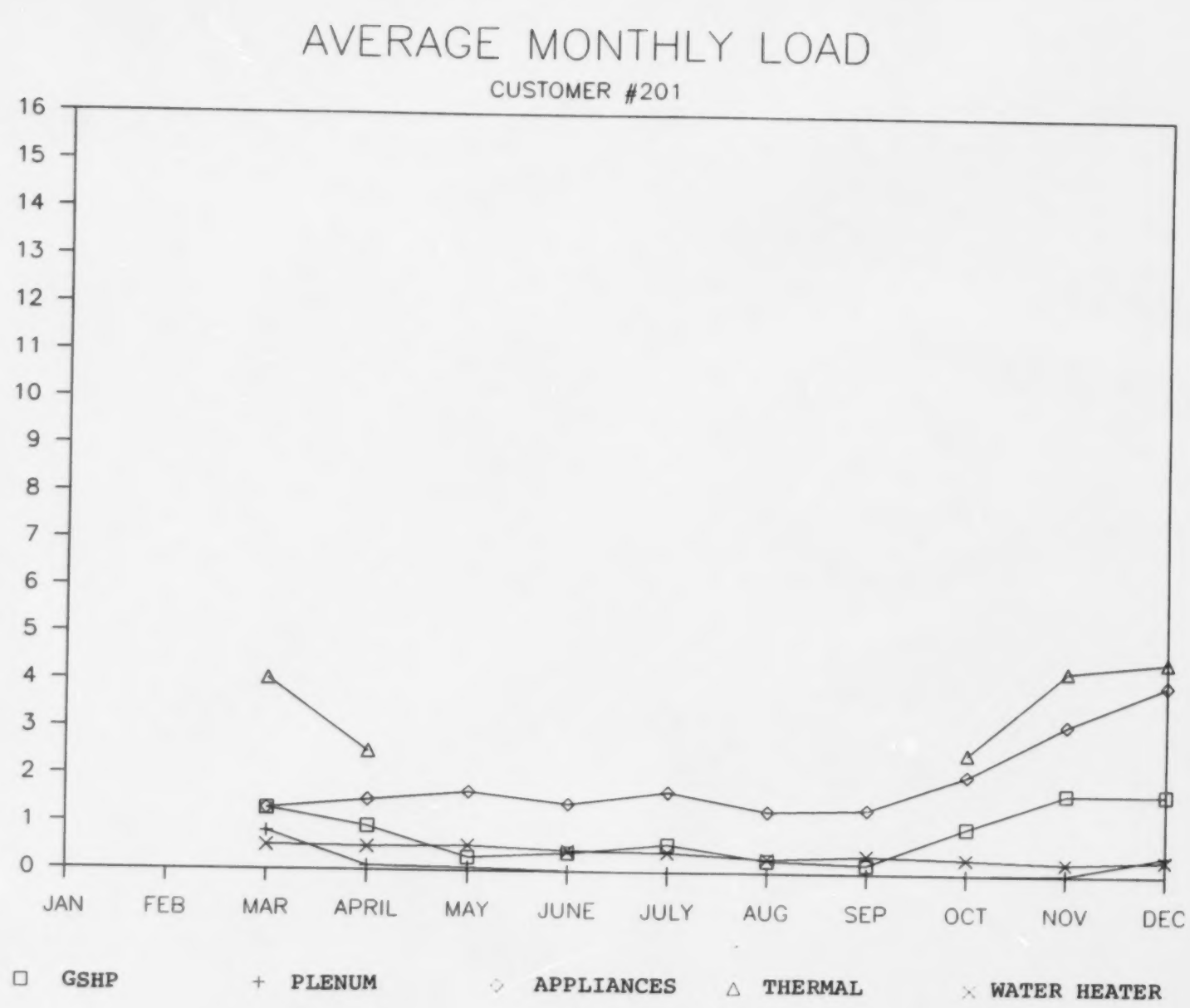

AVERAGE MONTHLY LOAD
CUSTOMER #201
AVERAGE MONTHLY LOAD (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
GSHP
PLENUM
APPLIANCES
THERMAL
WATER HEATER

FIGURE A.27

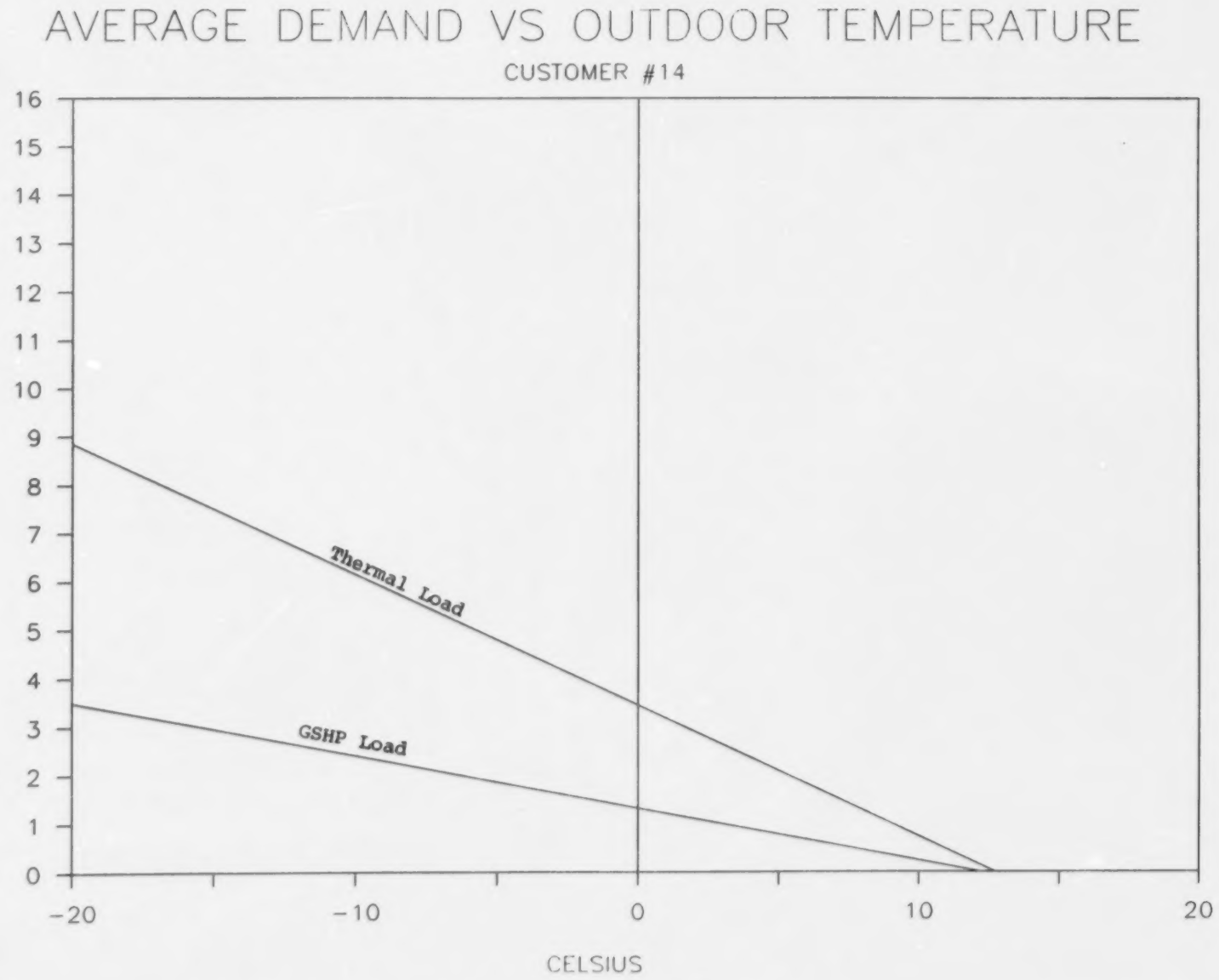

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #14
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.1

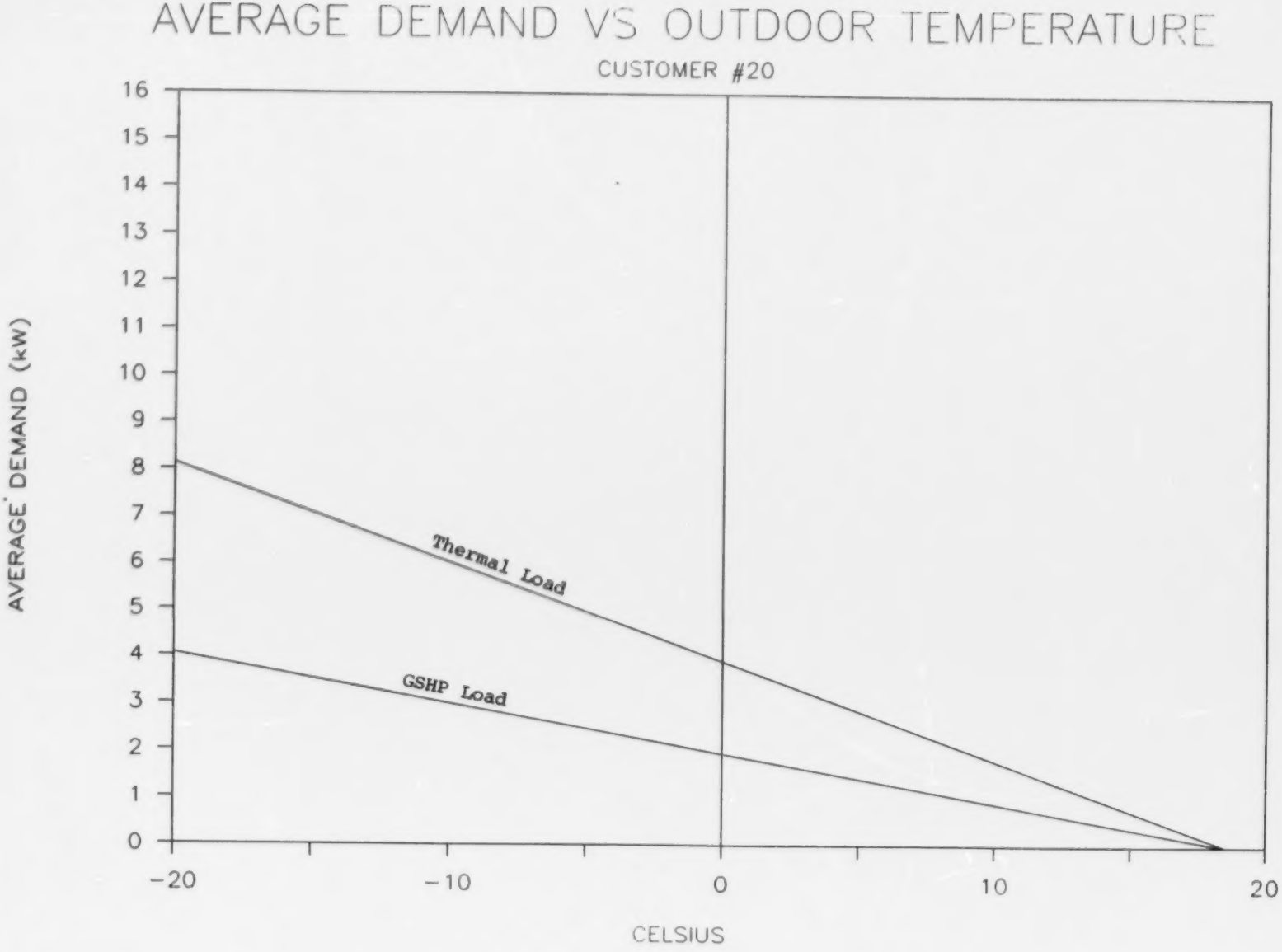

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #20
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.2

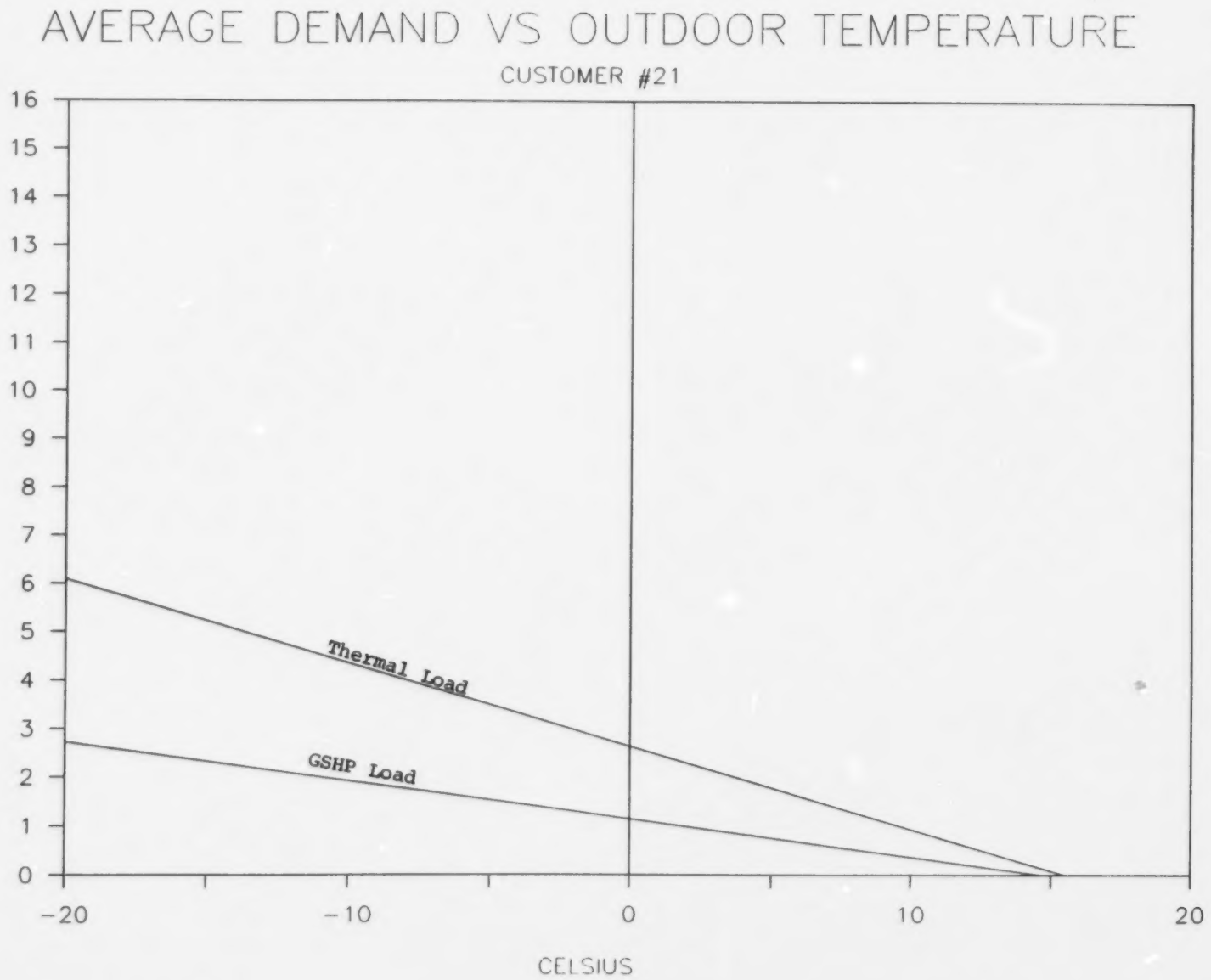

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #21
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.3

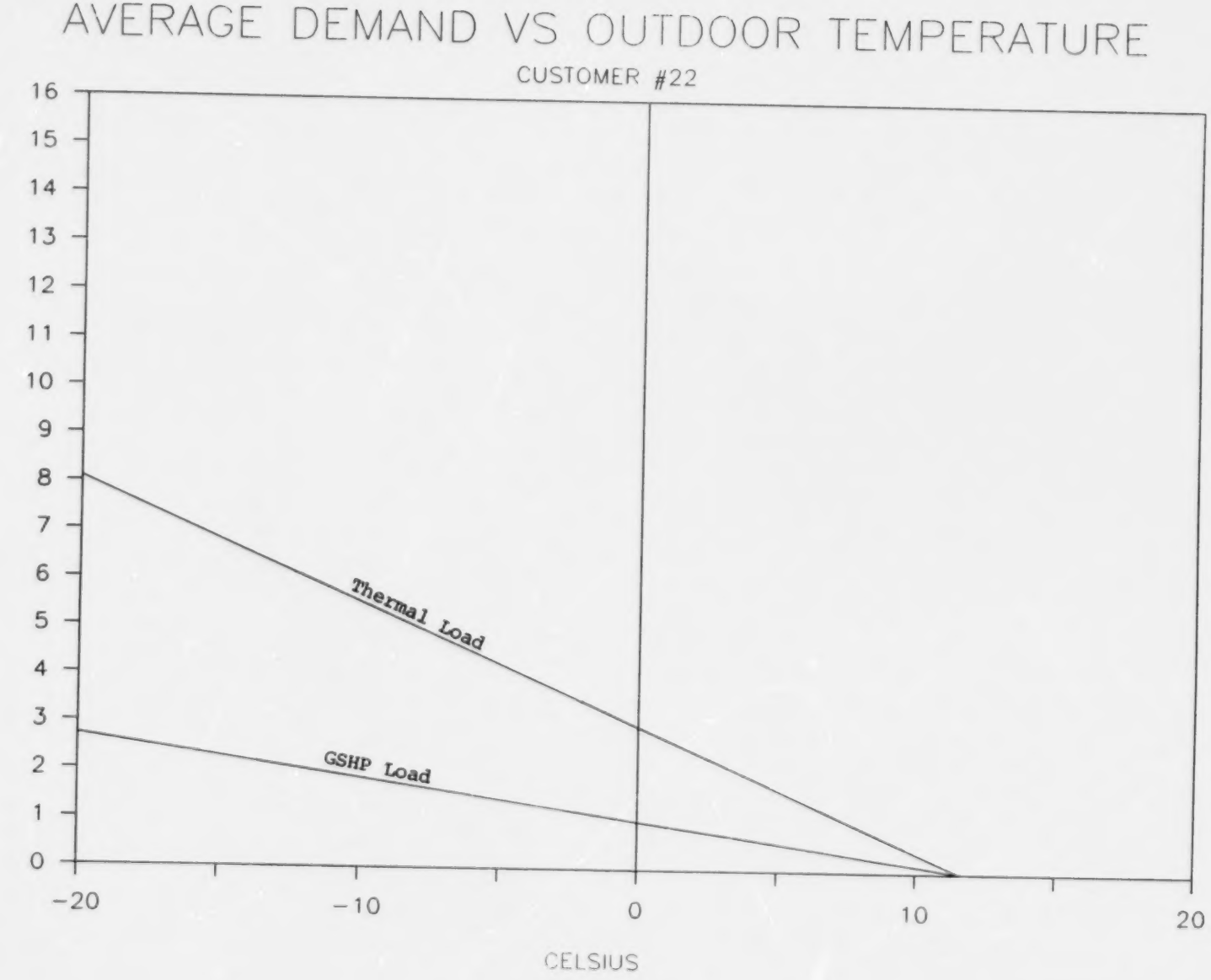

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #22
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.4

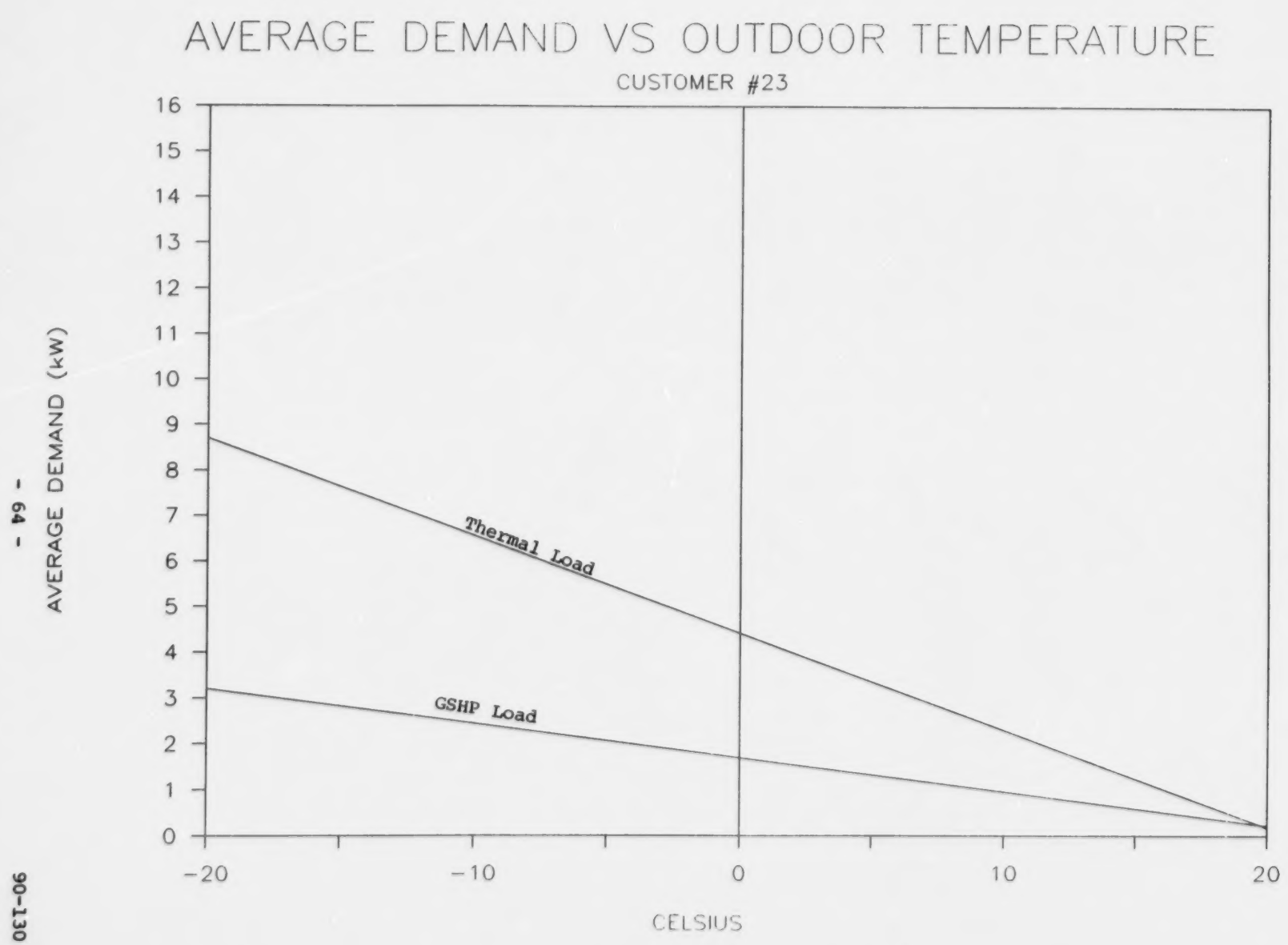

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #23
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.5

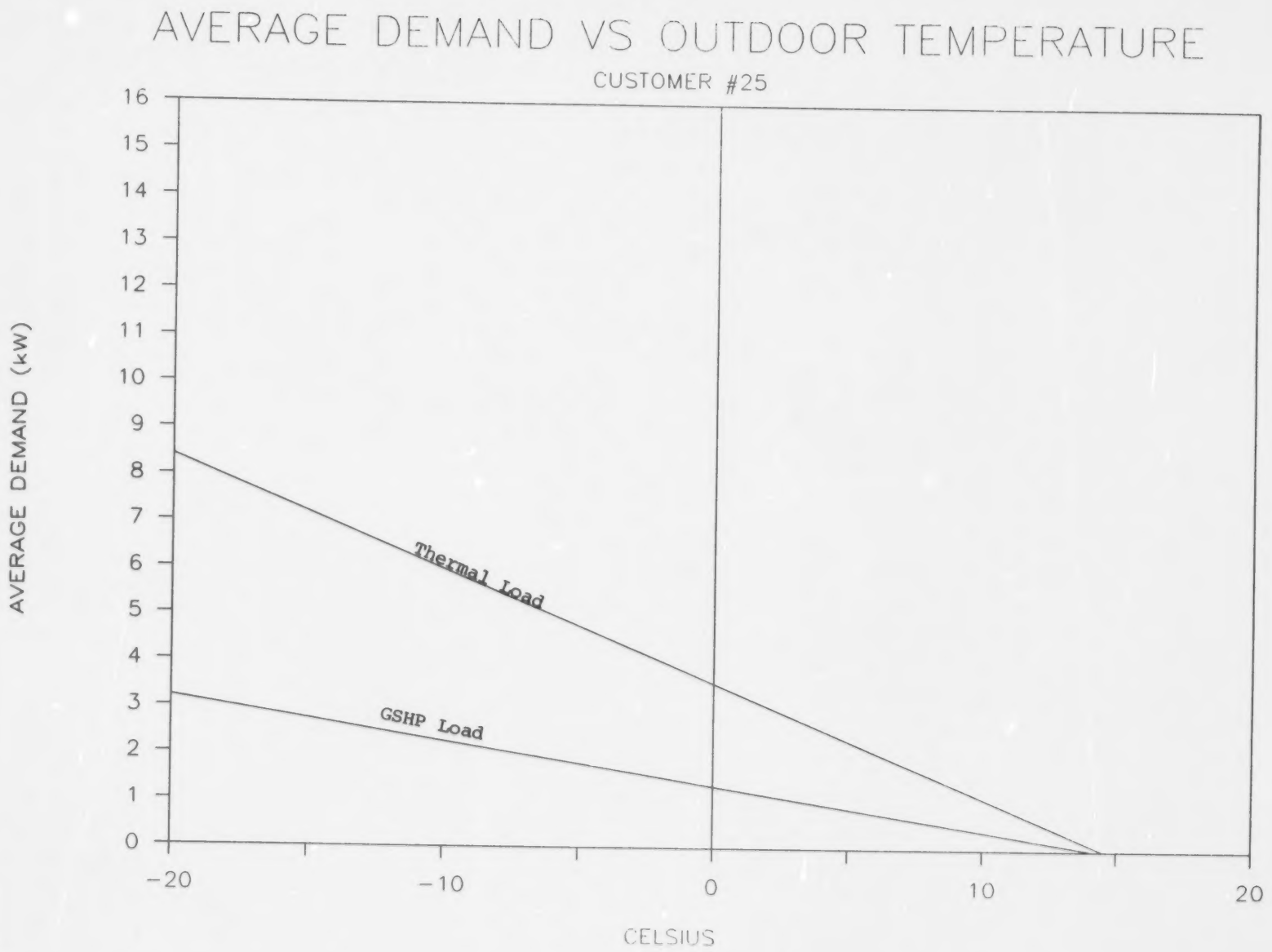

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #25
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.6

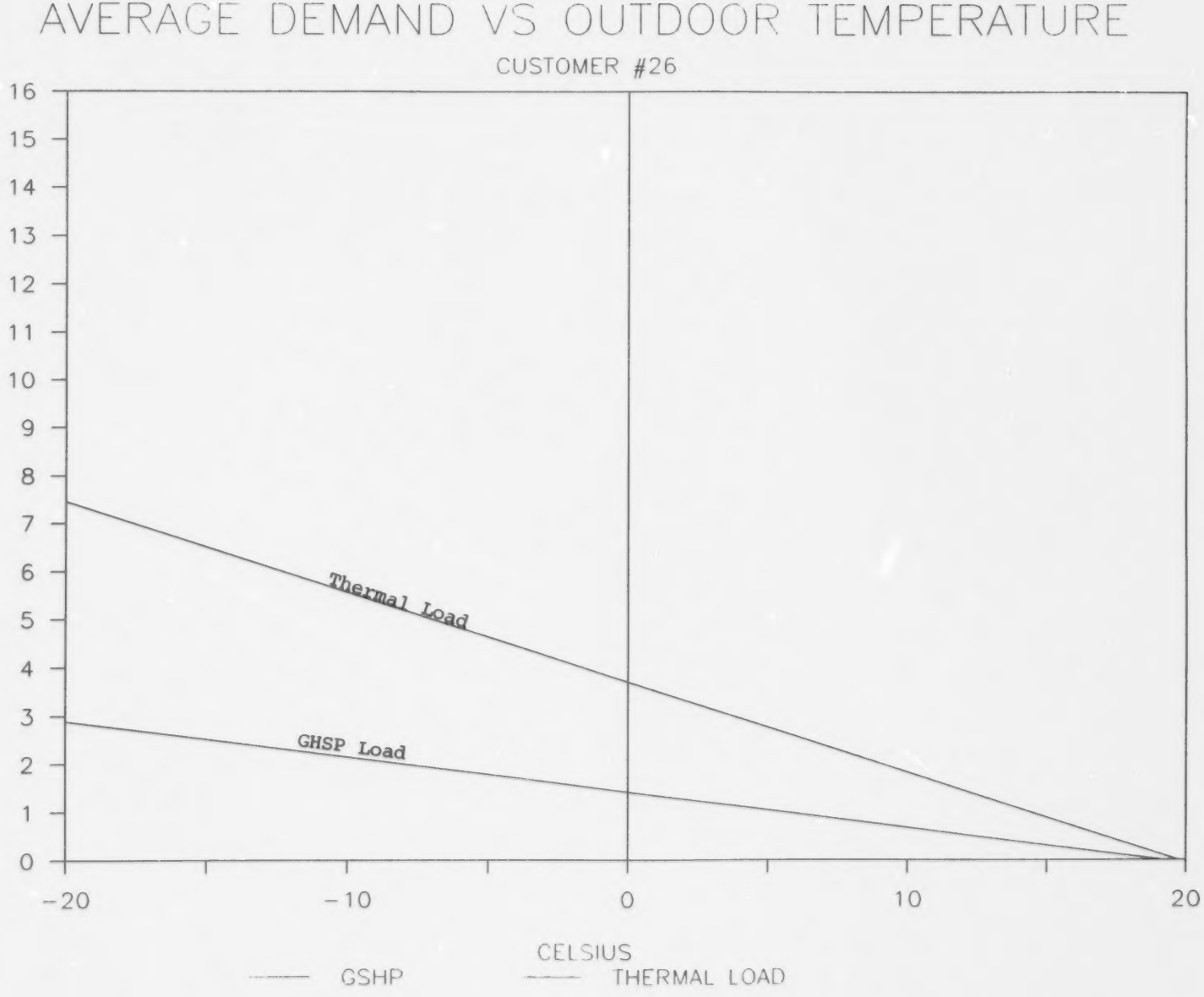

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #26
kW
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GHSP Load
-20
-10
0
10
20
CELSIUS
GSHP
THERMAL LOAD

FIGURE B.7

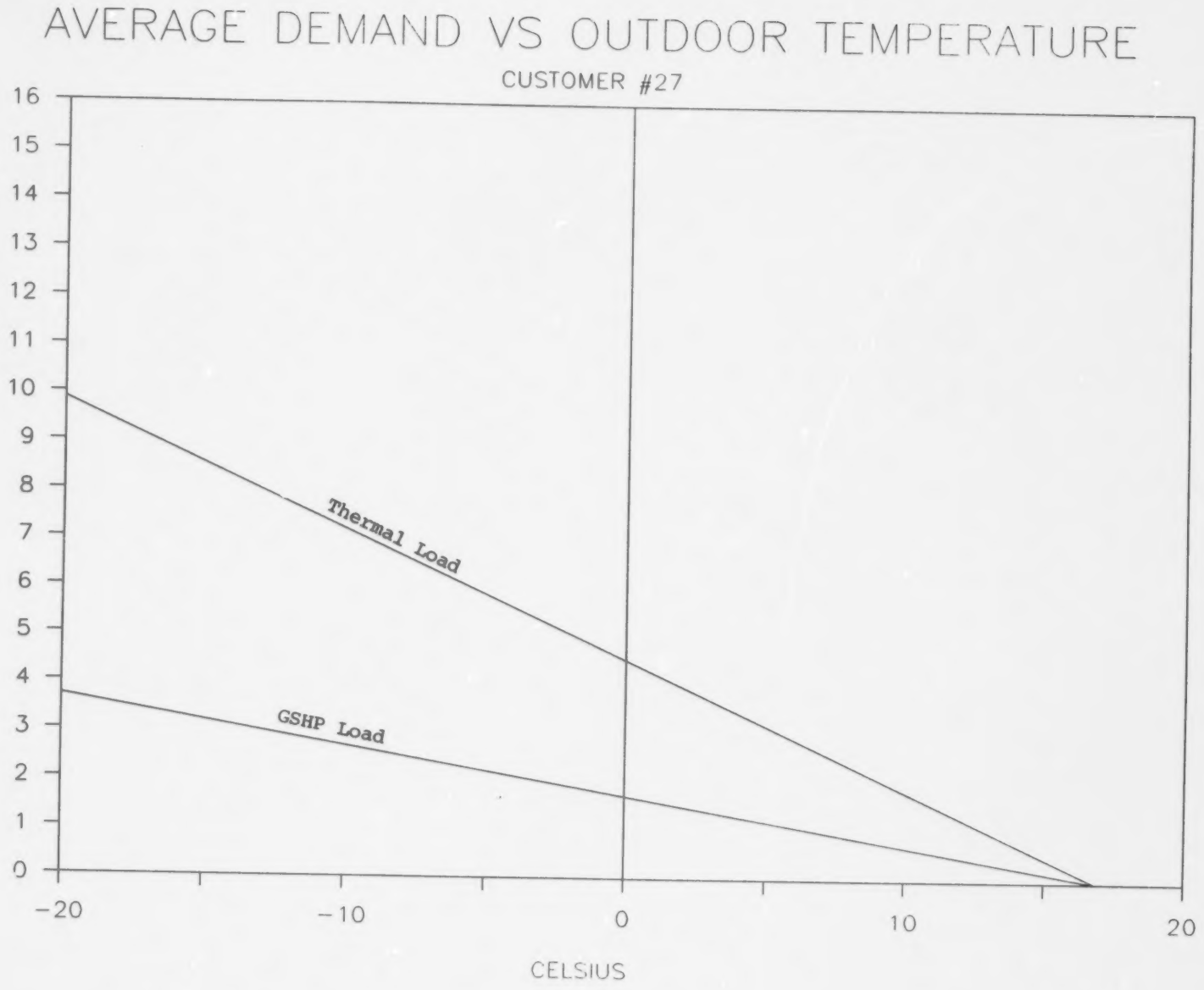

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #27
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.8

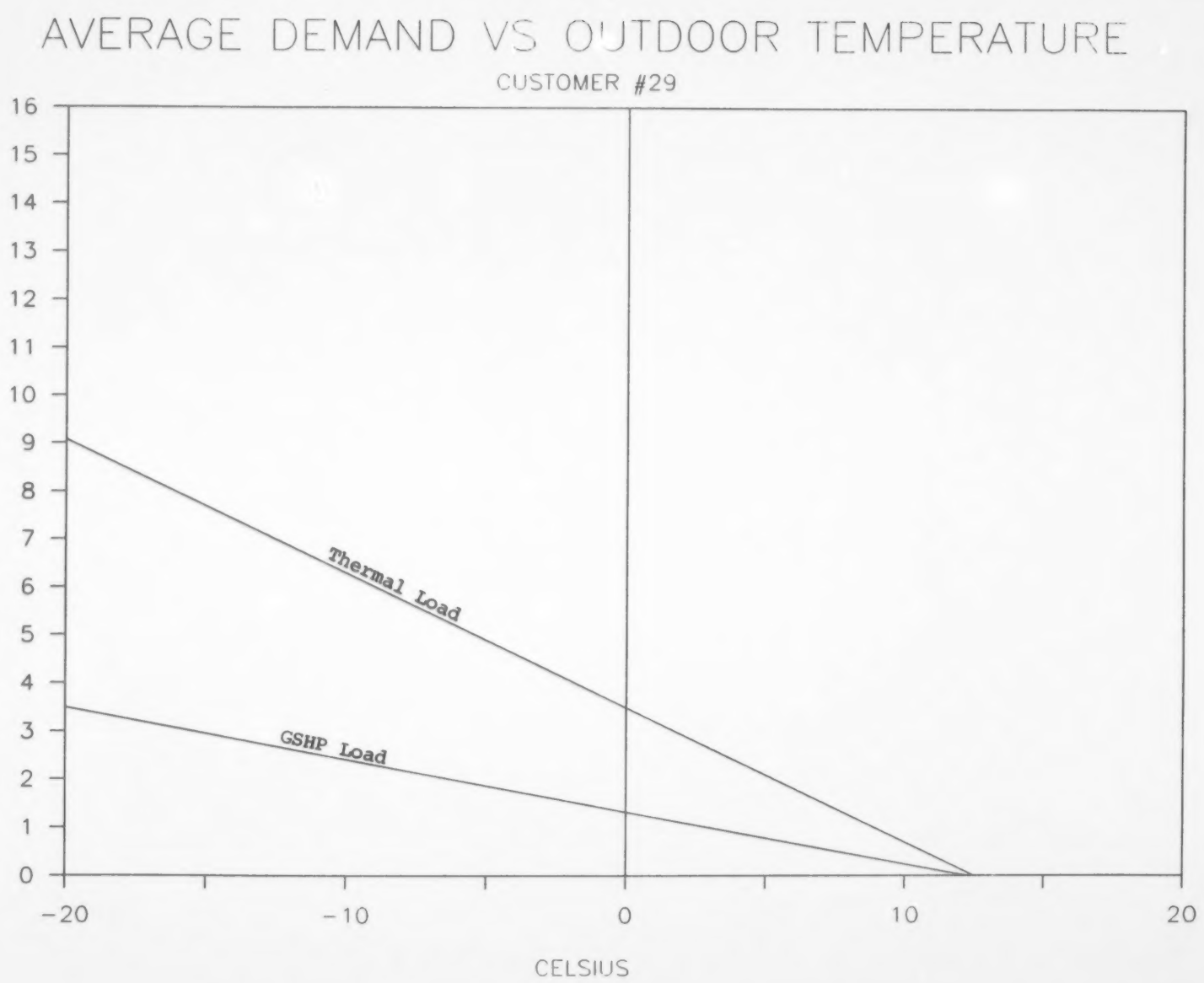

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #29
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.9

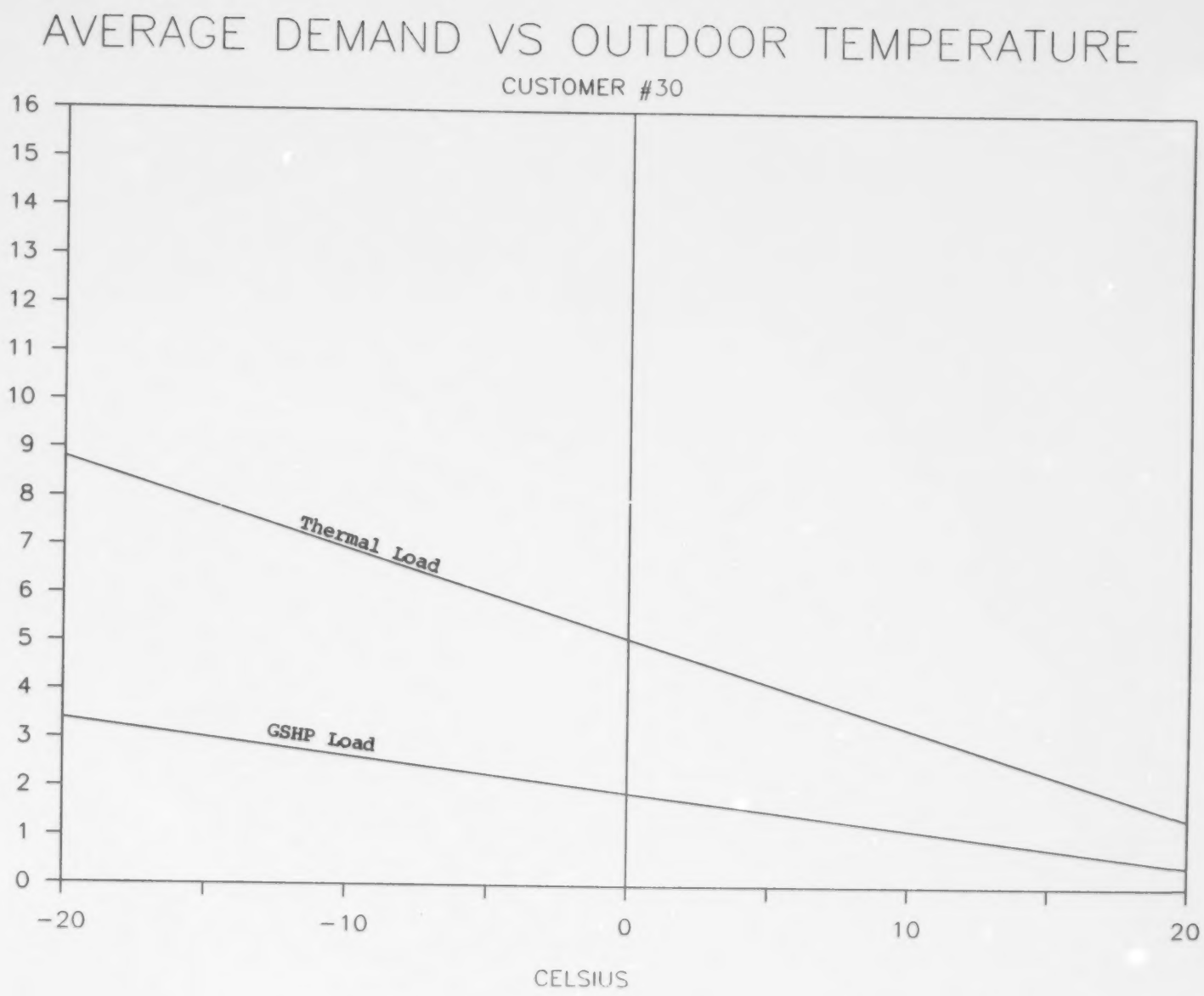

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #30
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.10

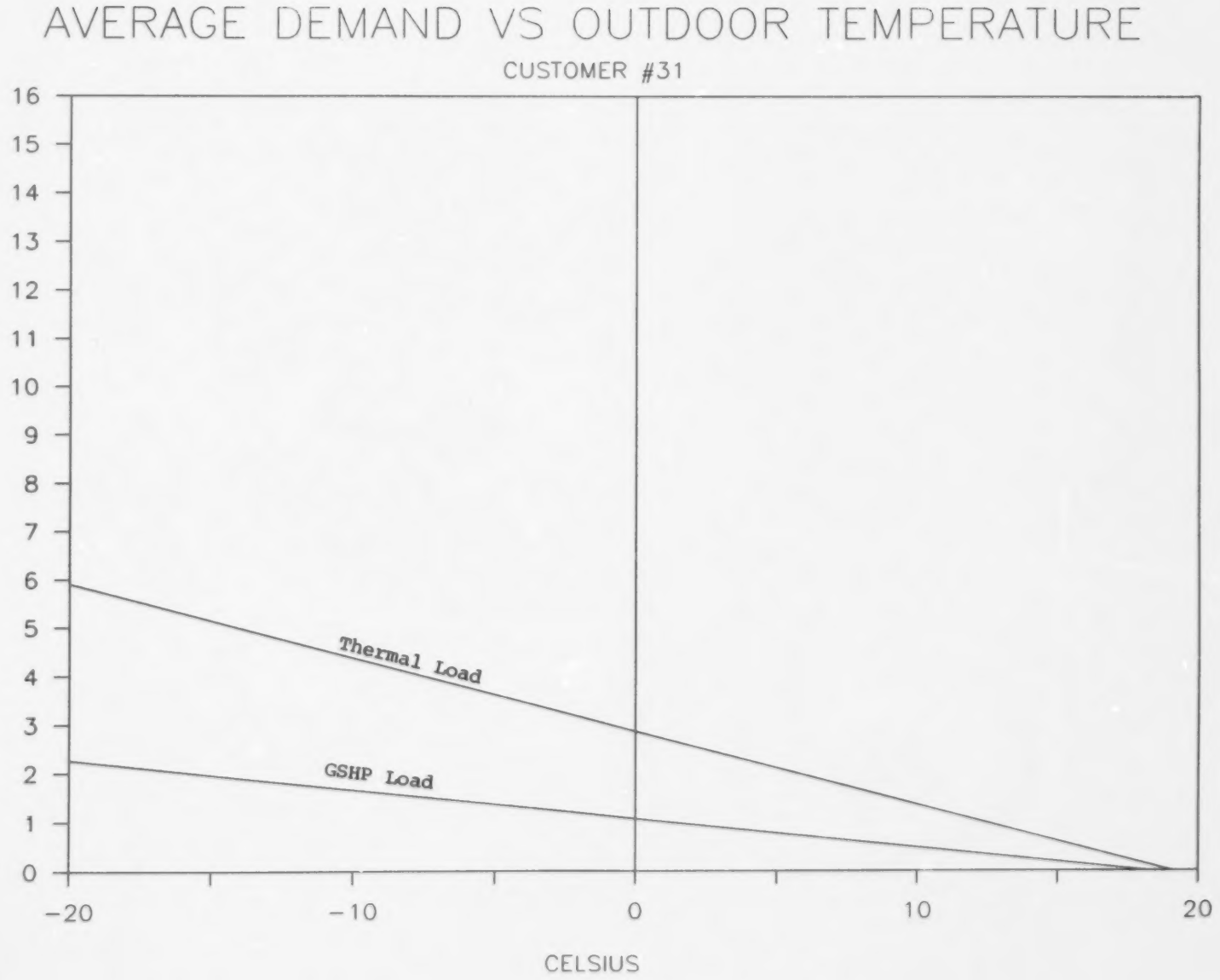

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #31
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.11

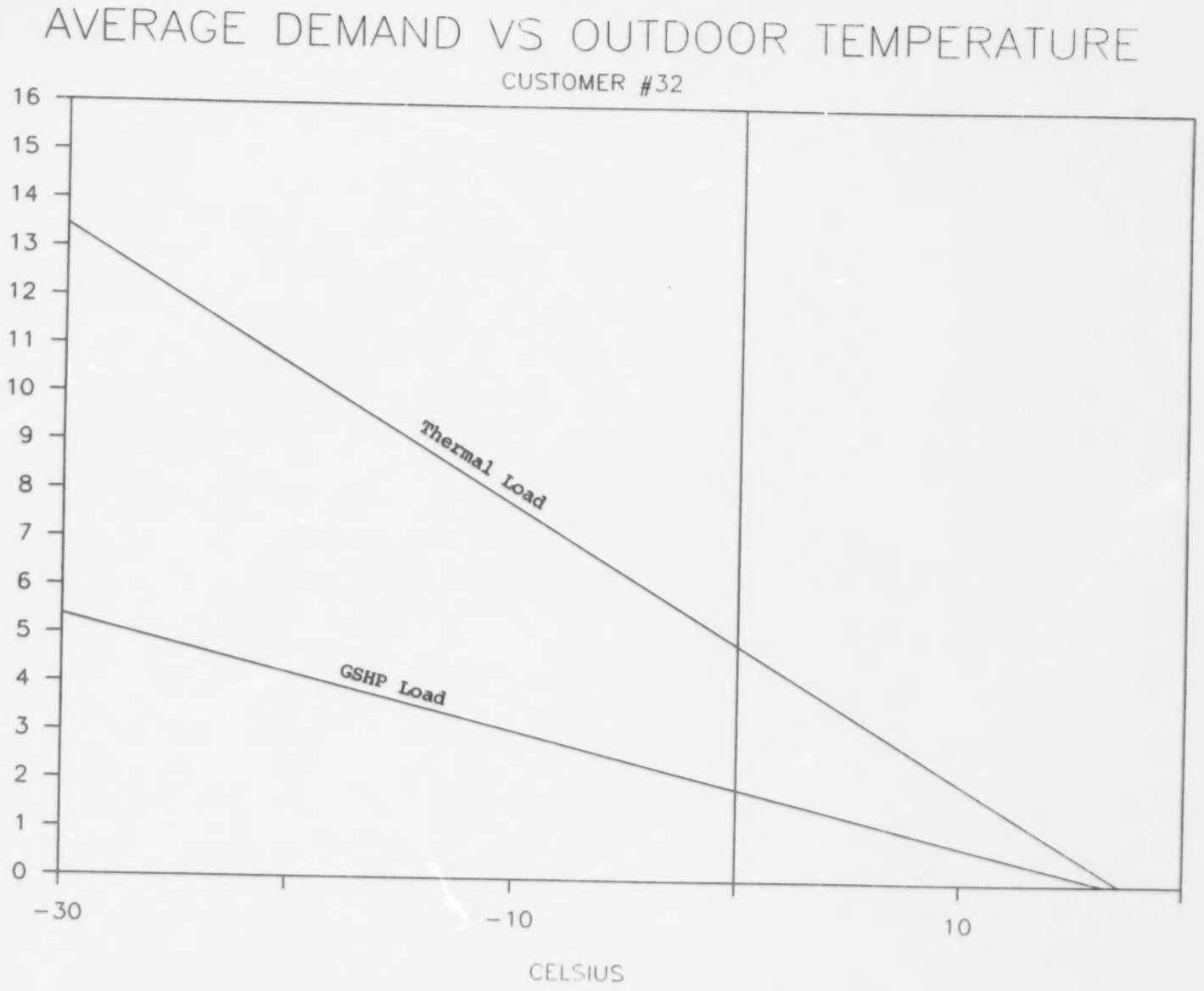

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #32
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-30
-10
10
CELSIUS

FIGURE B.12

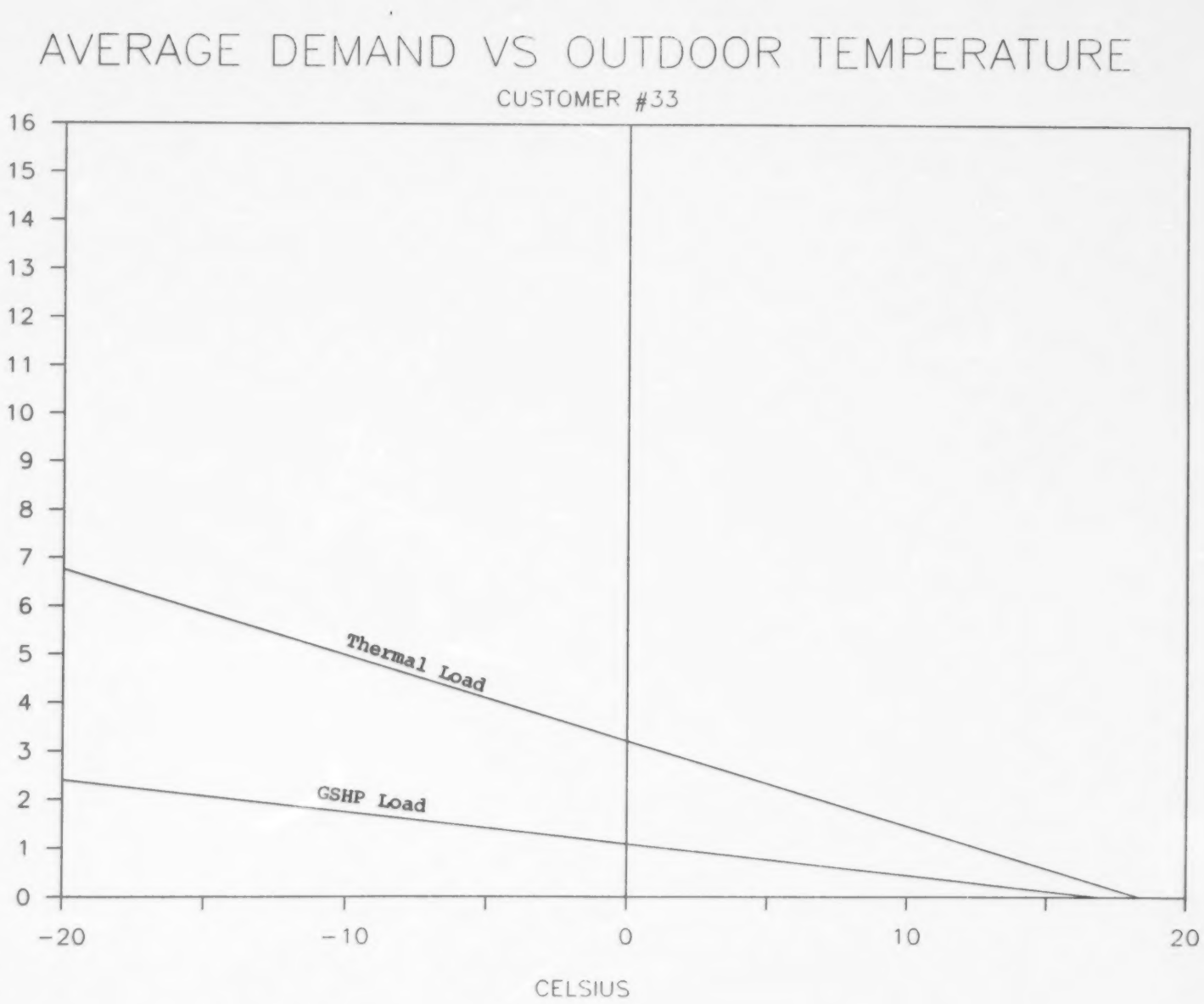

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #33
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.13

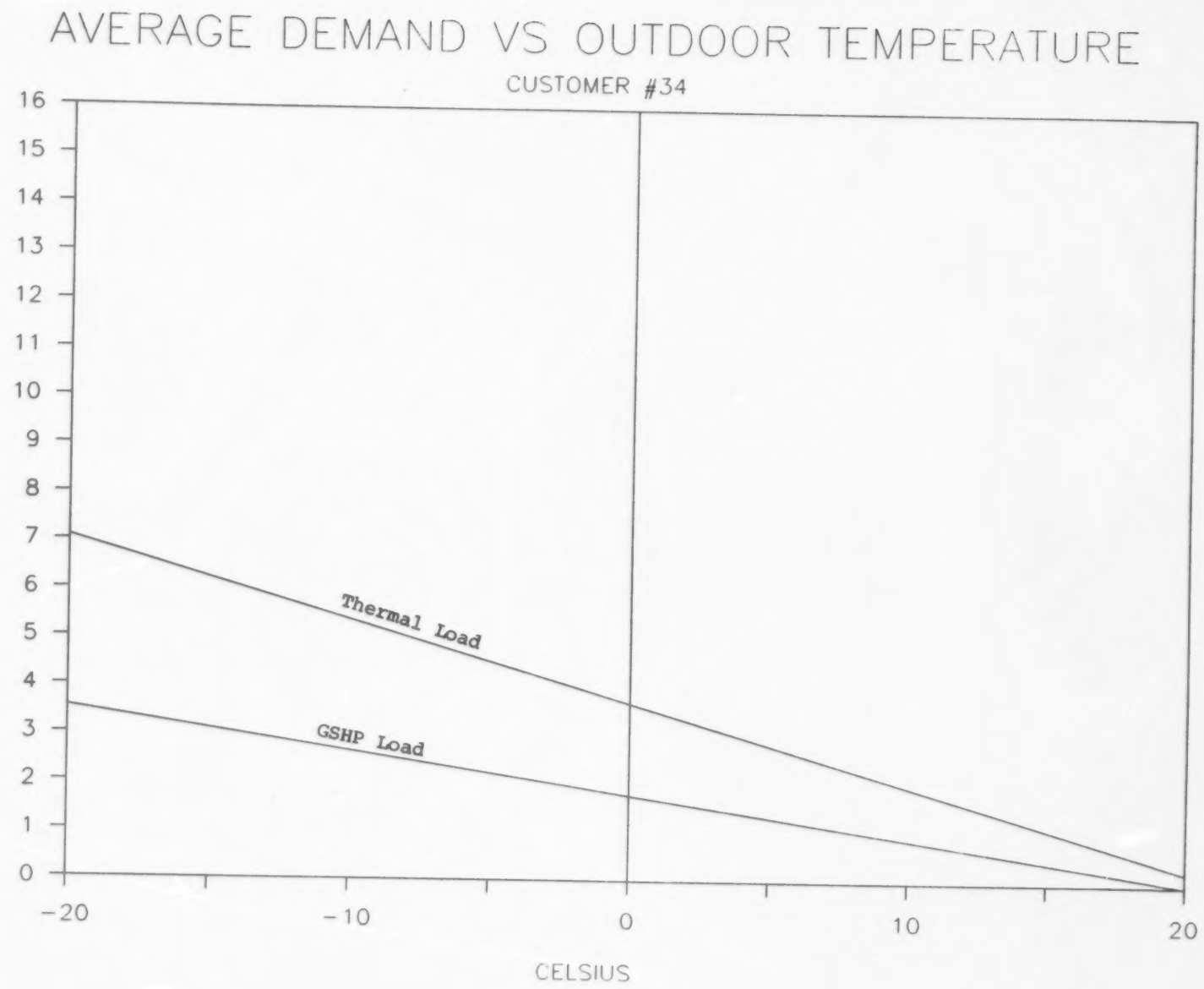

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #34
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.14

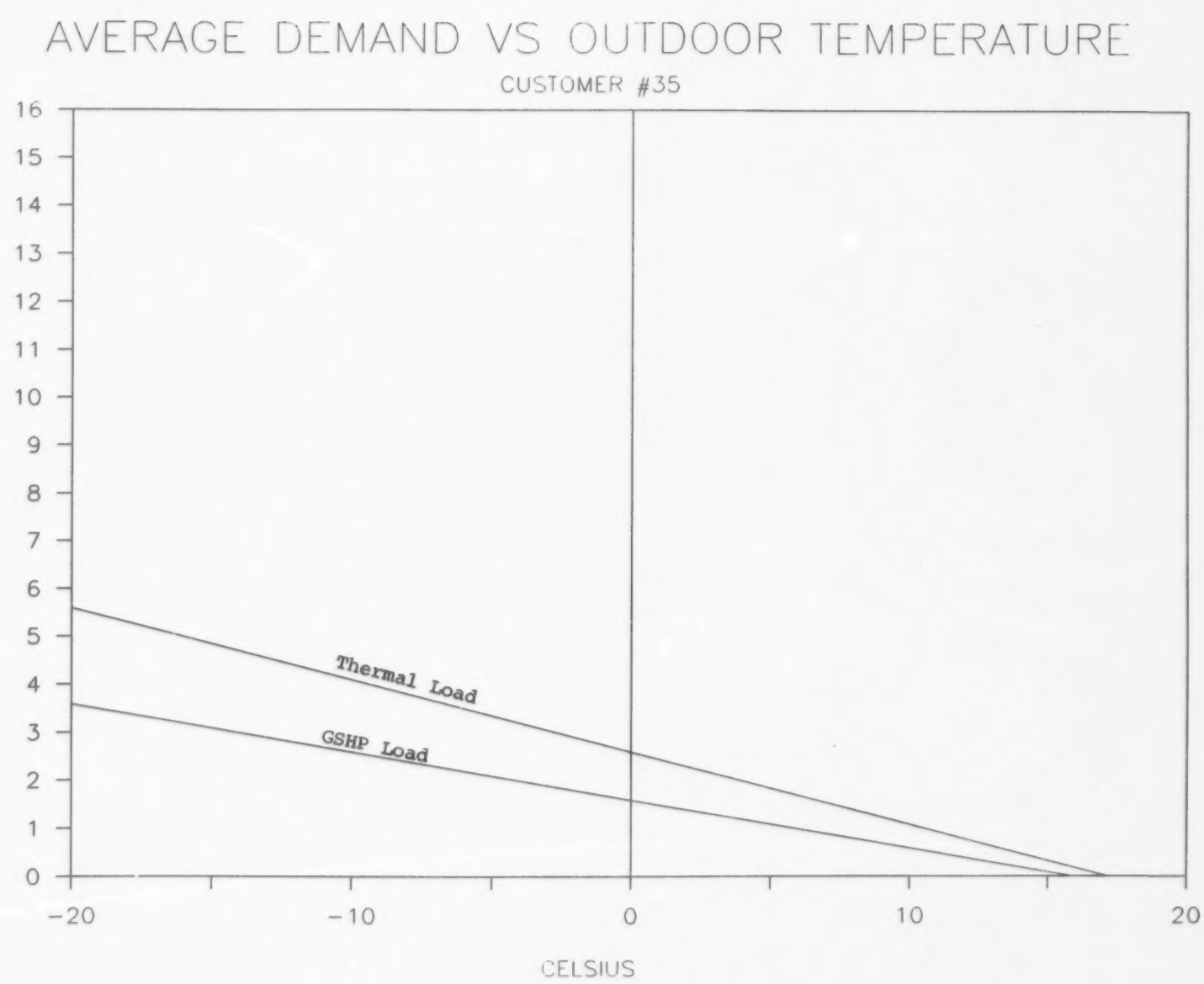

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #35
kW
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.15

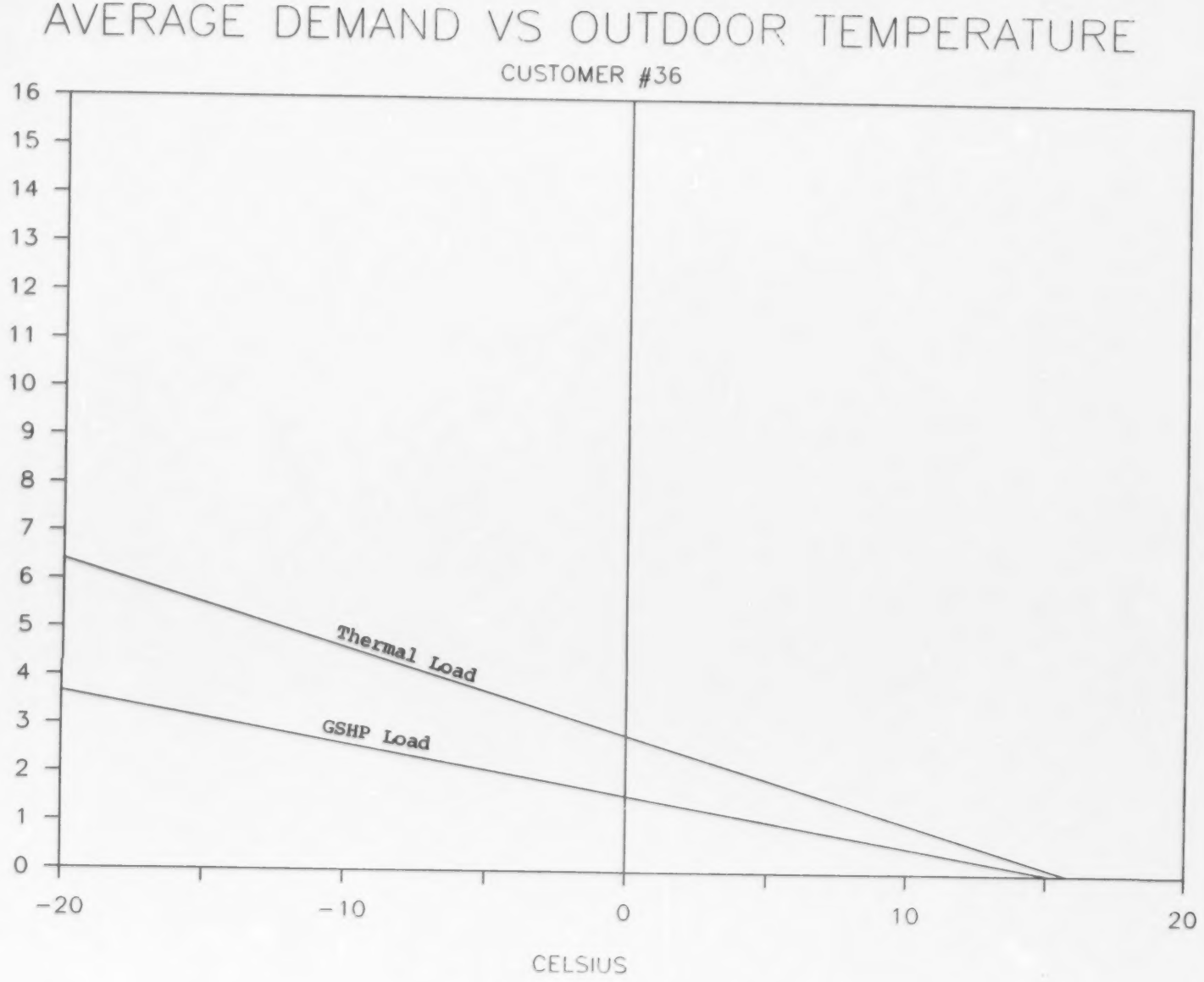

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #36
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.16

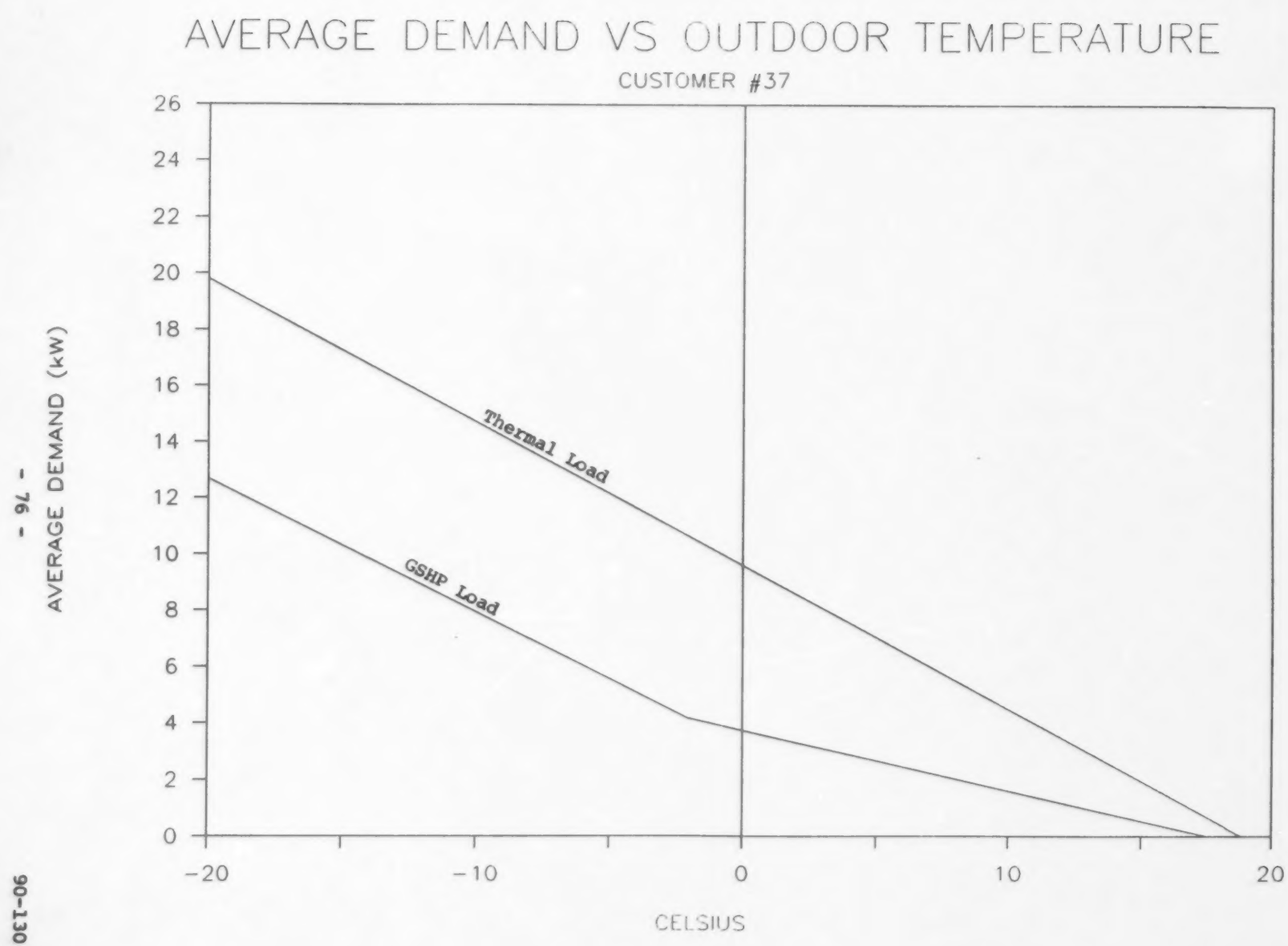

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #37
AVERAGE DEMAND (kW)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.17

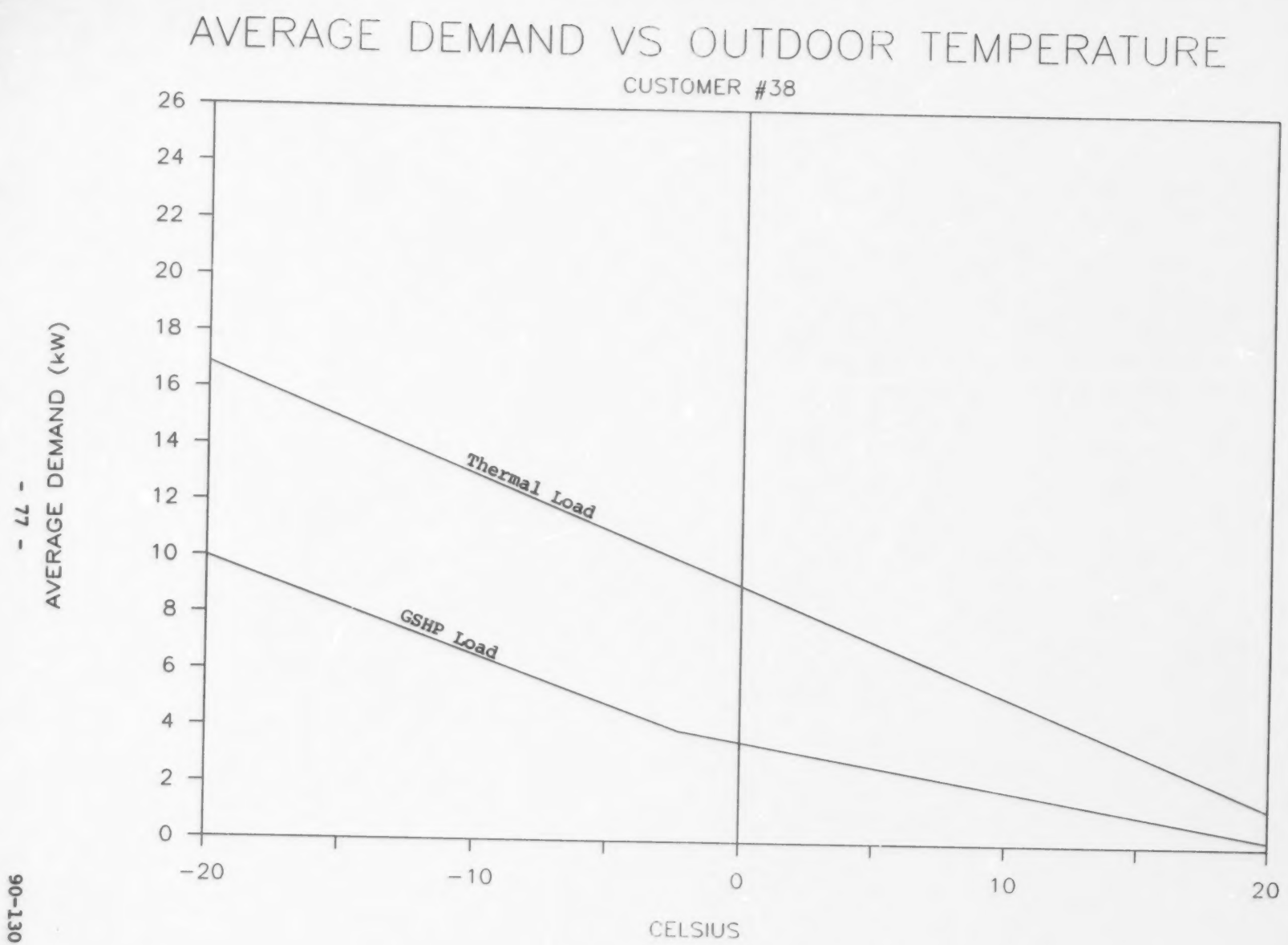

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #38
AVERAGE DEMAND (kW)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.18

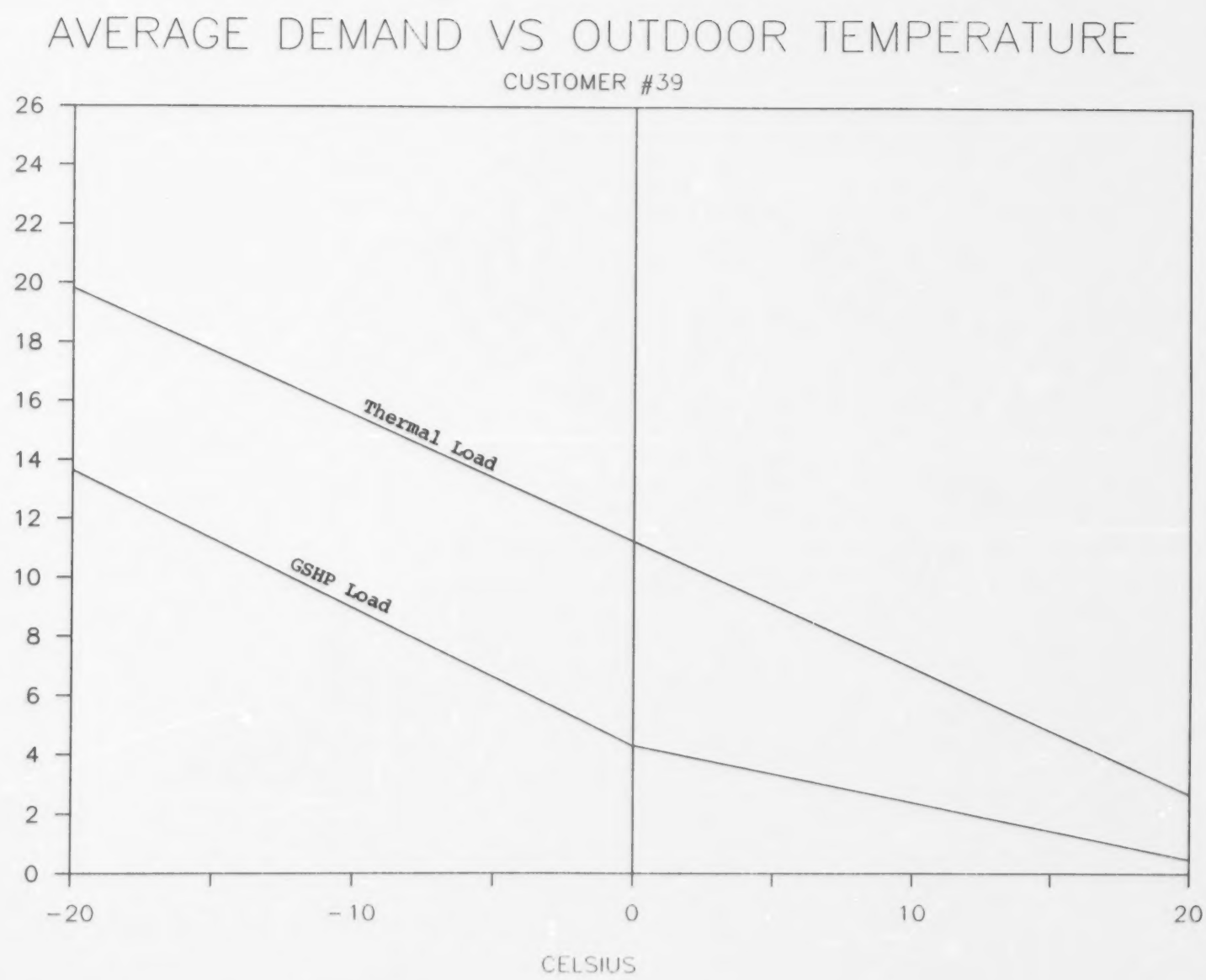

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #39
AVERAGE DEMAND (kW)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.19

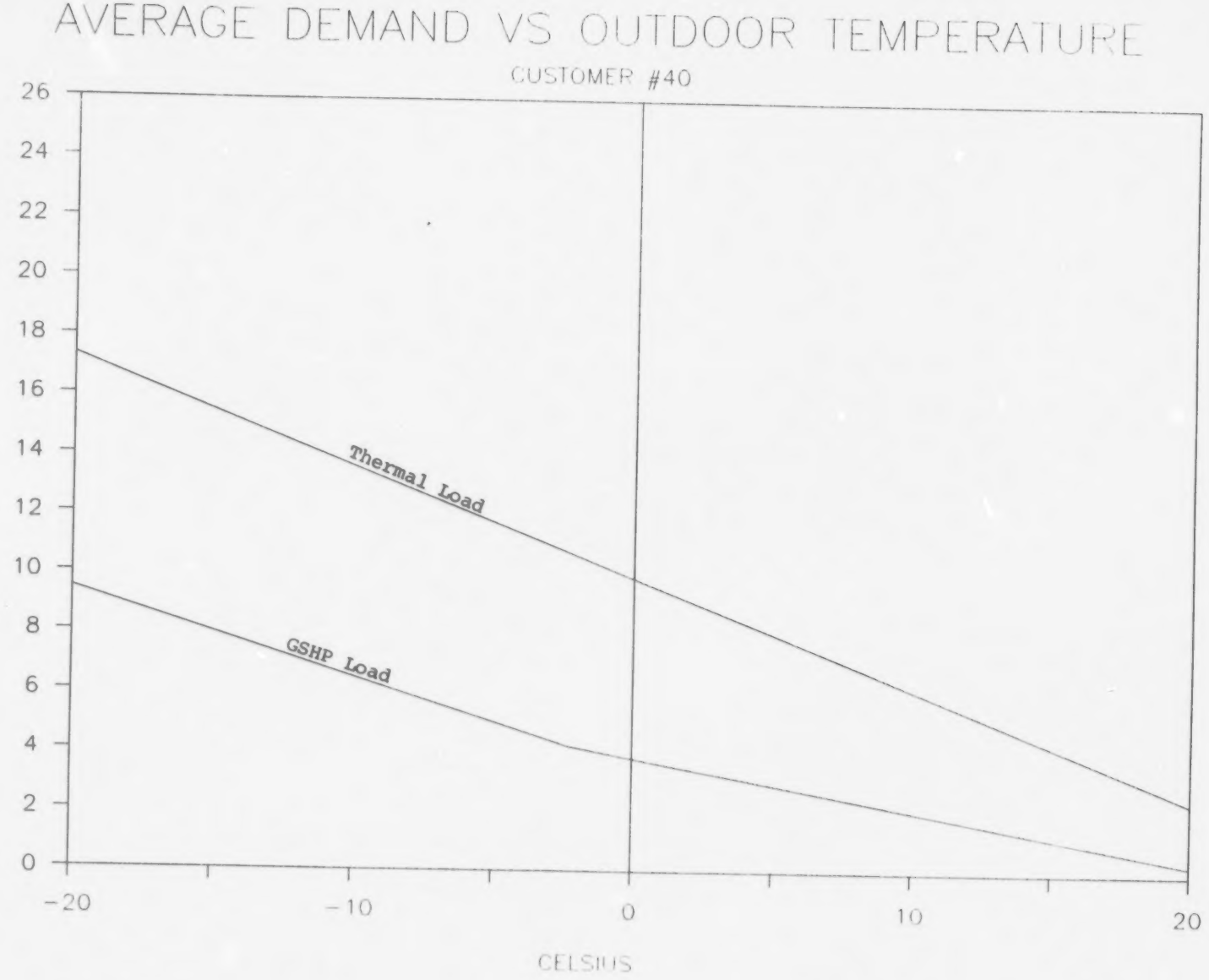

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #40
AVERAGE DEMAND (kW)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.20

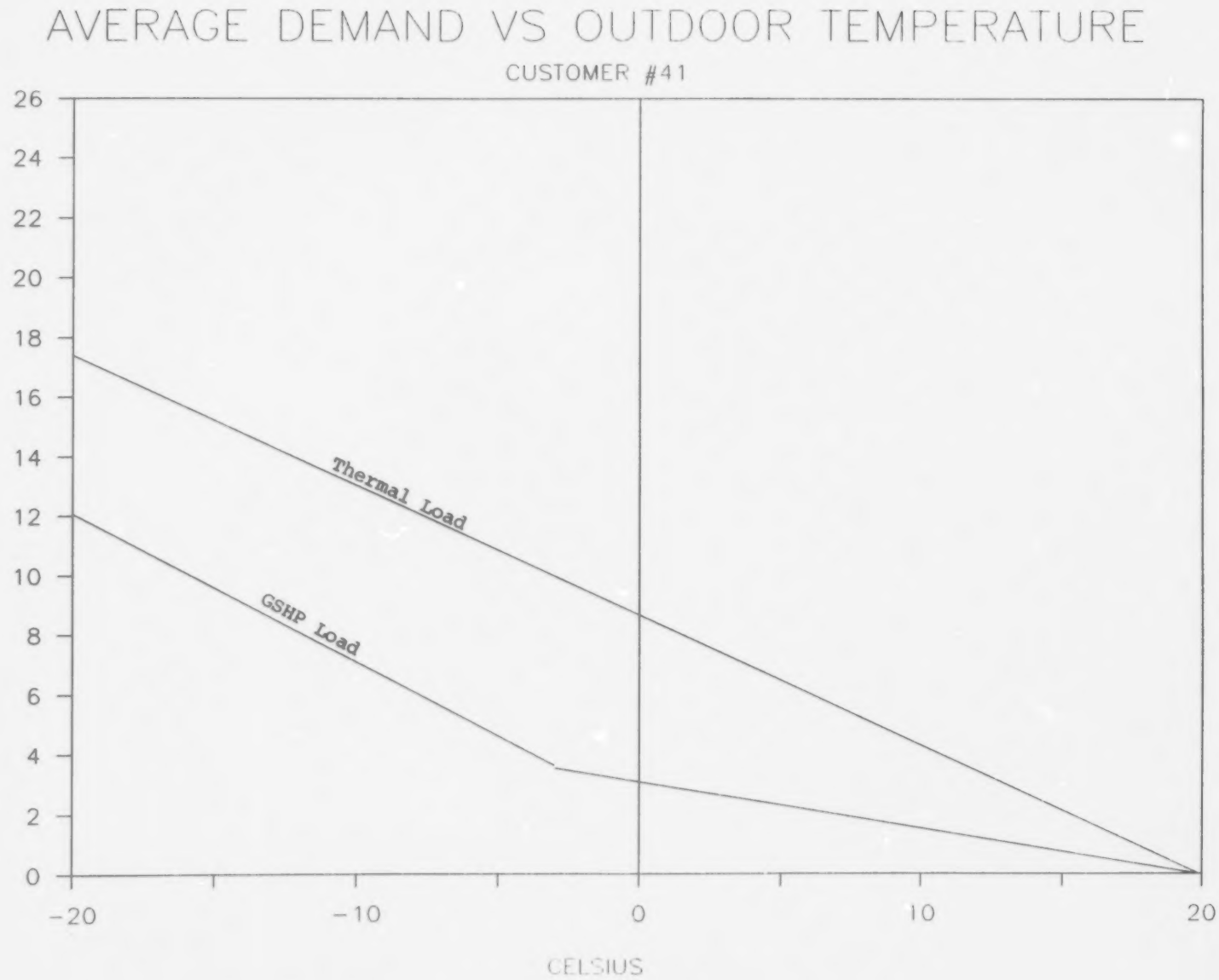

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #41
AVERAGE DEMAND (kW)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.21

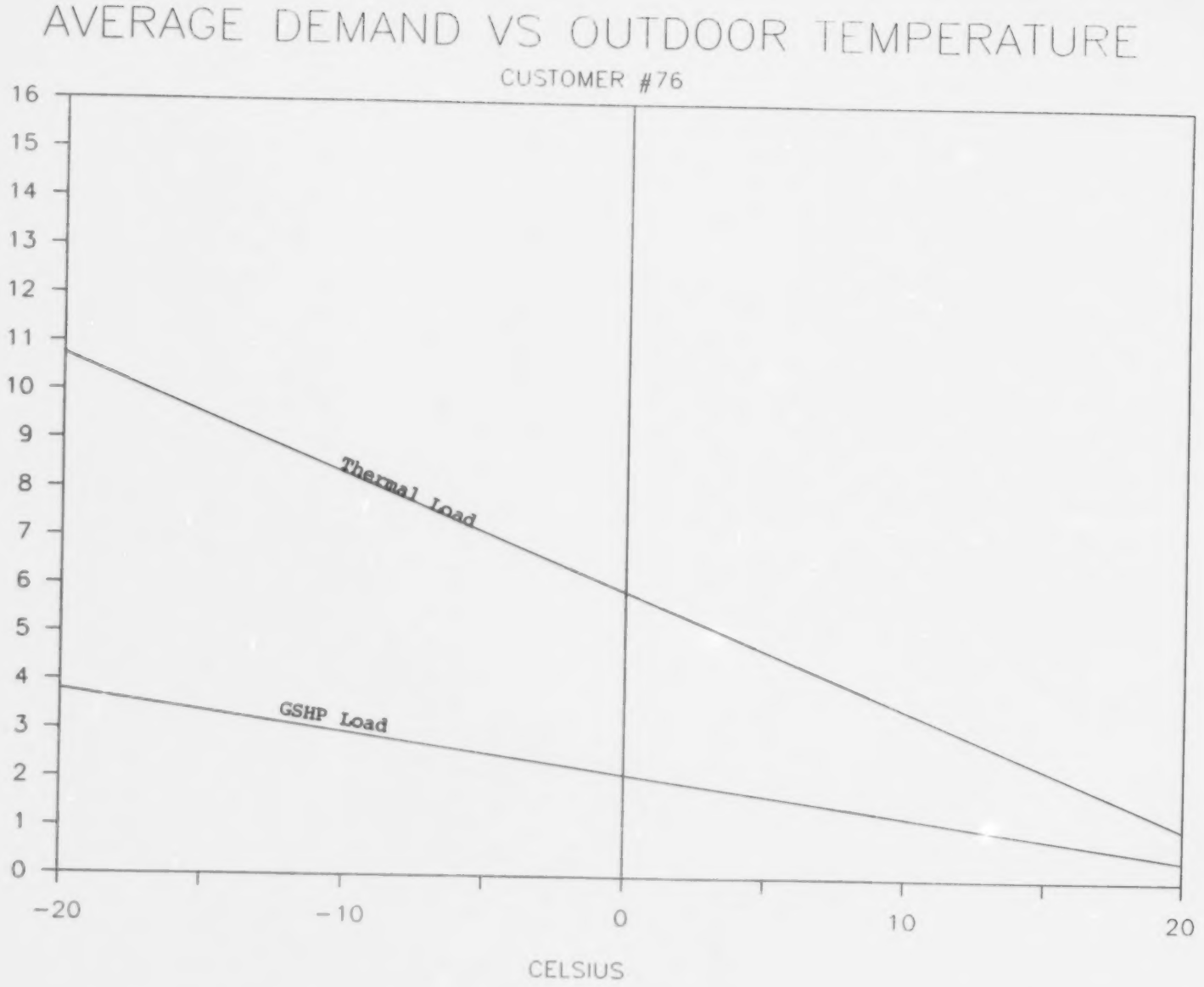

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #76
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.22

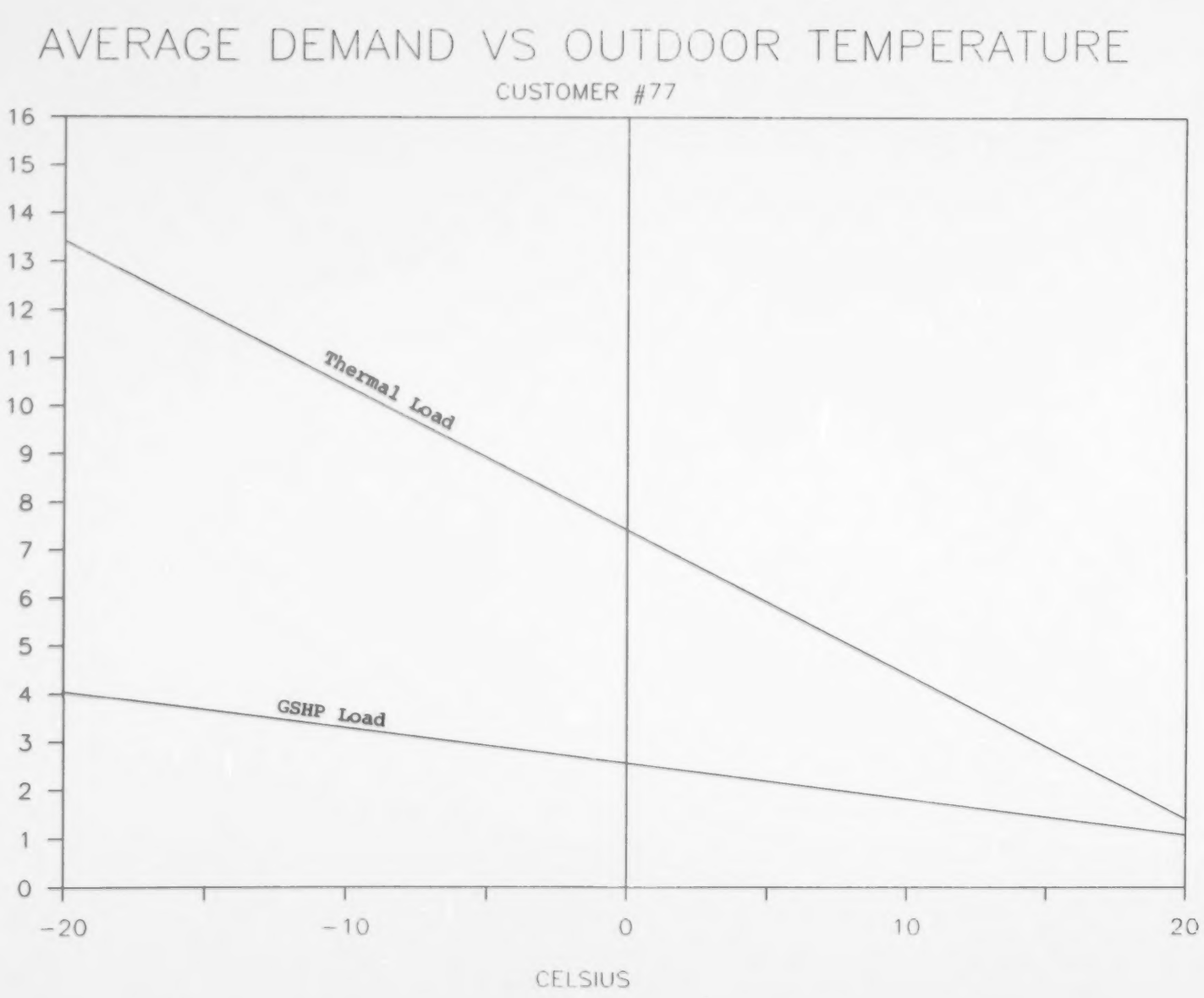

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #77
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.23

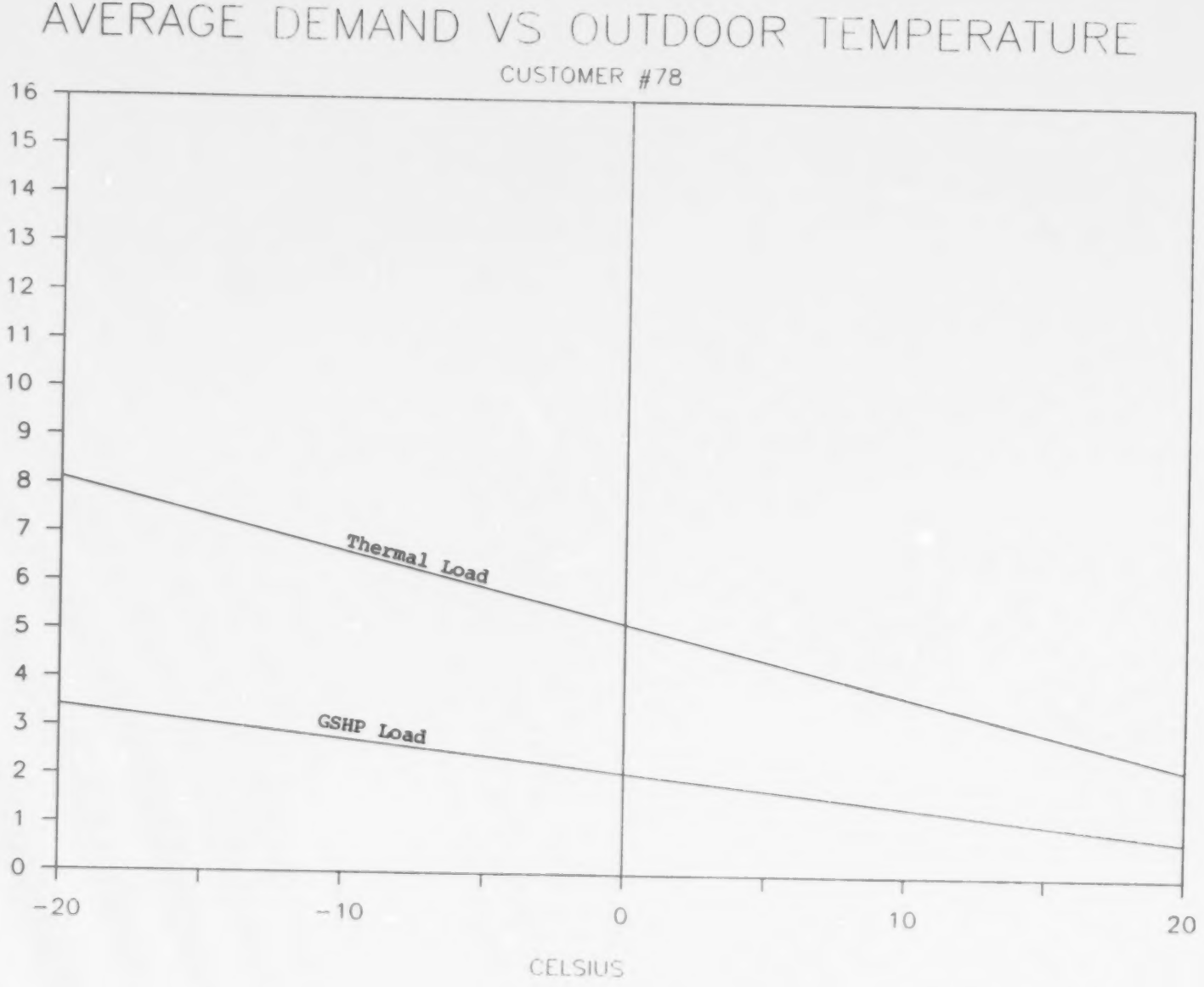

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #78
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.24

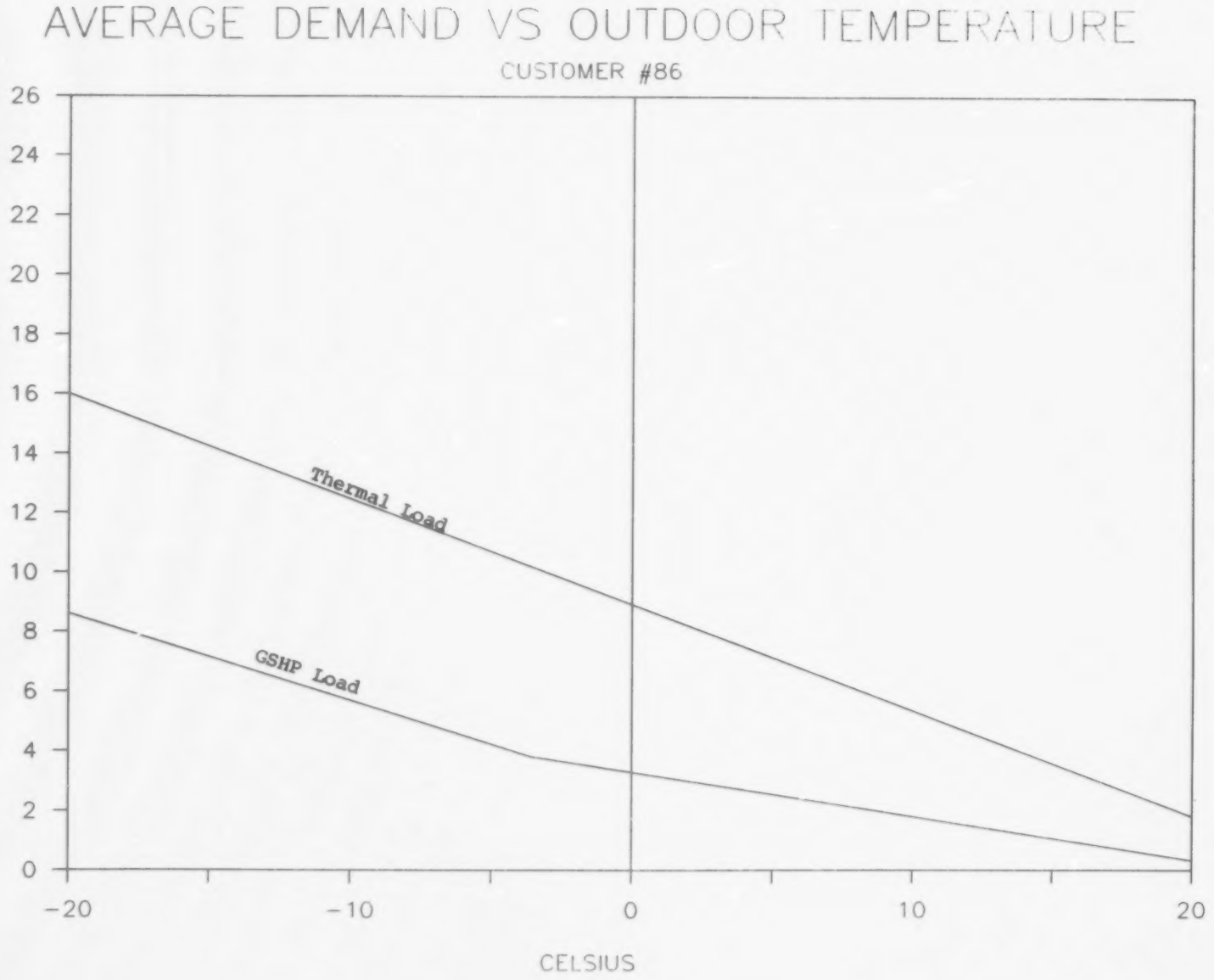

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #86
AVERAGE DEMAND (kW)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.25

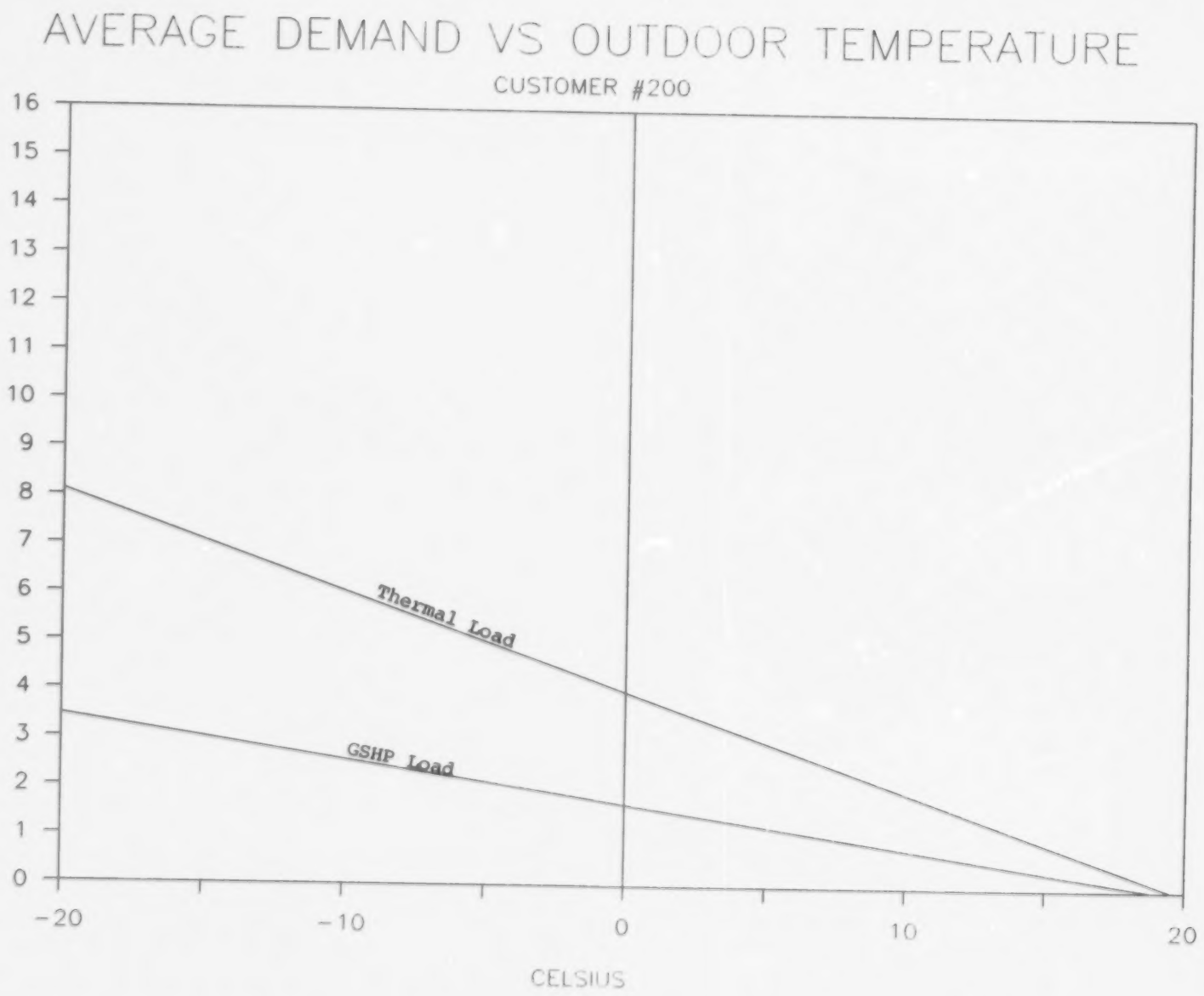

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #200
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.26

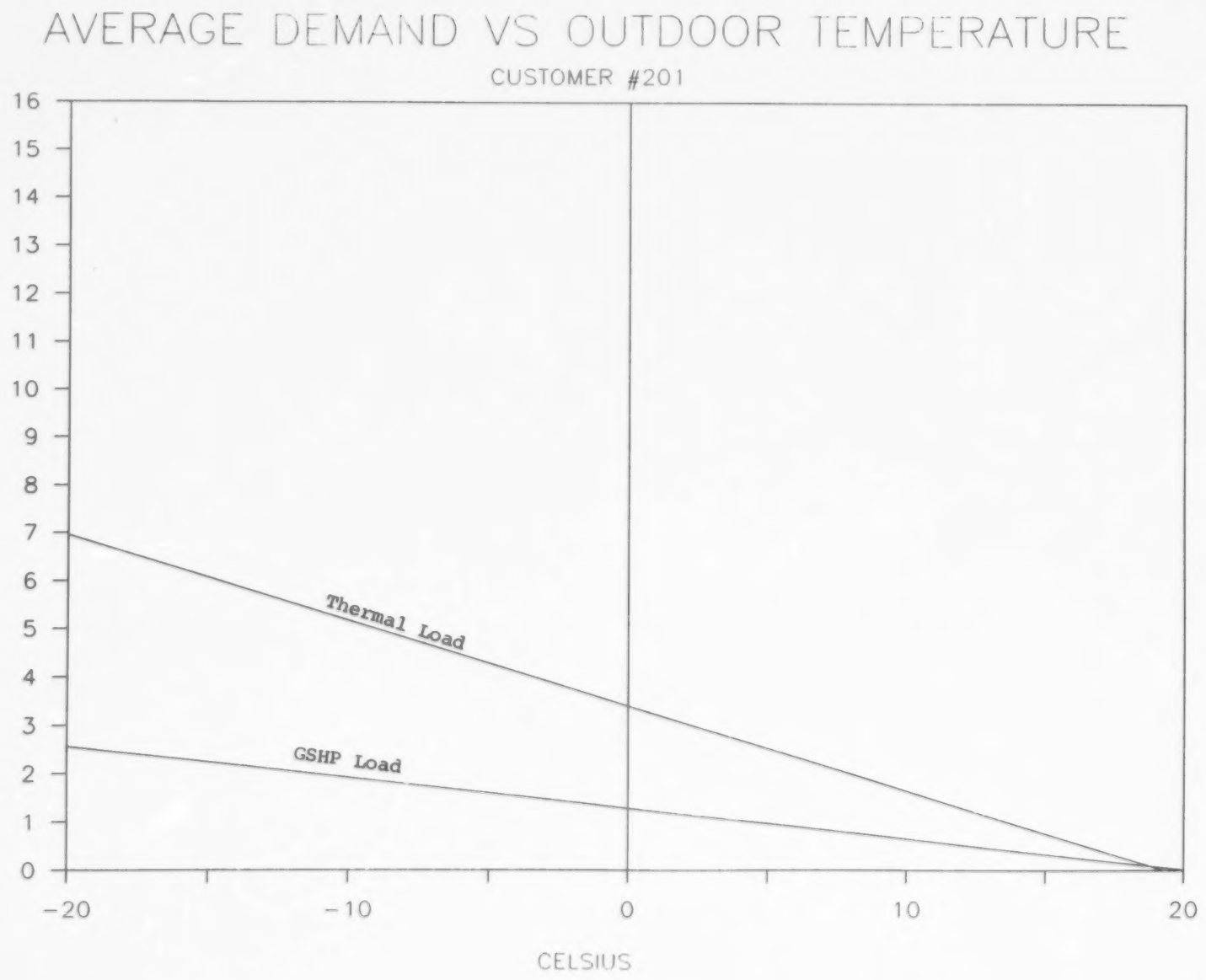

AVERAGE DEMAND VS OUTDOOR TEMPERATURE
CUSTOMER #201
AVERAGE DEMAND (kW)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Thermal Load
GSHP Load
-20
-10
0
10
20
CELSIUS

FIGURE B.27

ATTACHMENT I

List of GSHP-Installed Homes

1. Customer #14
   Richmond Hill
   Channel Description
   - 1 Total Load
   - 2 GSHP Load
   - 3 Plenum Load
   - 4 Glycol

2. Customer #20
   New Liskeard
   Channel Description
   - 1 GSHP Load
   - 2 Plenum Load
   - 3 Water Heater Load
   - 4 Total Load

3. Customer #21
   New Liskeard
   Channel Description
   - 1 GSHP Load
   - 2 Plenum Load
   - 3 Water Heater Load
   - 4 Total Load

4. Customer #22
   New Liskeard
   Channel Description
   - 1 GSHP Load
   - 2 Plenum Load
   - 3 Total Load
   - 4 Temperature

5. Customer #23
   New Liskeard
   Channel Description
   - 1 Total Load
   - 1 GSHP Load (under cust. #24)
   - 2 Plenum Load (-do-)
   - 3 Water Heater Load (-do-)

Continued...

ATTACHMENT I

6. Customer #25
London
Channel Description
1 Total Load
2 GSHP and Plenum Load
3 Plenum Load
4 Water Heater Load

7. Customer #26
Niagara Falls
Channel Description
1 GSHP Load
2 Plenum Load
3 Water Heater Load
4 Total Load

8. Customer #27
Niagara Falls
Channel Description
1 GSHP Load
2 Plenum
4 Total Load
5 Hot Water Load
6 Glycol

9. Customer #29
Callander
Channel Description
1 Total Load
2 GSHP Load
3 Plenum Load
4. Water Heater Load

10. Customer #30
North Bay
Channel Description
1 Total Load
2 GSHP Load
3 Plenum Load
4 Water Heater load

Continued...

11. Customer #31
North Bay
Channel Description
1 Total Load
2 GSHP Load
3 Plenum Load
4 Water Heater Load

12. Customer #32
Greely
Channel Description
1 Well Pump Load
2 GSHP Load
3 Plenum Load
4 Total Load
5 Glycol

13. Customer #33
Greely
Channel Description
1 Well Pump Load
2 GSHP Load
3 Plenum Load
4 Total Load

14. Customer #34
Greely
Channel Description
1 Well Pump Load
2 GSHP Load
3 Plenum Load
4 Total Load

15. Customer #35
Greely
Channel Description
1 Well Pump Load
2 GSHP Load
3 Plenum Load
4 Total Load

Continued...

ATTACHMENT I

16. Customer #36
Greely
Channel Description
1 Well Pump Load
2 GSHP Load
3 Plenum Load
4 Total Load

17. Customer #37
Richmond Hill
Channel Description
1 GSHP Load
2 Plenum Load
3 Glycol
4 Total Load

18. Customer #38
Richmond Hill
Channel Description
1 GSHP Load
2 Plenum Load
3 Glycol
4 Total Load

19. Customer #39
Richmond Hill
Channel Description
1 GSHP Load
2 Plenum Load
4 Total Load

20. Customer #40
Richmond Hill
Channel Description
1 GSHP Load
2 Plenum Load
3 Glycol
4 Total Load

Continued...

21. Customer #41
Richmond Hill
Channel Description
1 GSHP Load
2 Plenum Load
3 Glycol
4 Total Load

22. Customer #76
Echo Bay
Channel Description
1 Total Load
2 GSHP Load
3 Plenum Load
4 Water Heater Load

23. Customer #77
Sault Saint Marie
Channel Description
1 Total Load
2 GSHP Load
3 Plenum Load
4 Water Heater Load

24. Customer #78
Sault Saint Marie
Channel Description
1 Total Load
2 GSHP Load
4 Water Heater Load

25. Customer #86
Alliston
Channel Description
1 GSHP Load
2 Plenum Load
3 Water Heater Load
4 Total Load

Continued...

26. Customer #200
Kakabeka Falls
Channel Description

1	Total Load
2	GSHP Load

27. Customer #201
Thunder Bay
Channel Description

1	Total Load
1	GSHP Load (under cust. #49)
2	Water Heater Load (-do-)
3	Plenum Load (-do-)

ATTACHMENT II

List of Weather Stations Used for the Corresponding Areas

TORONTO INT'L AIRPORT
Locations:

- Richmond Hill
- Oakville
- Alliston

EARLTON
Locations:

- New Liskeard

LONDON
Location:

- London

SAULT SAINT MARIE
Location:

- Sault Saint Marie

SAINT CATHERINES
Locations:

- Niagara Falls

NORTH BAY
Locations:

- North Bay
- Echo Bay
- Callander

THUNDER BAY
Locations:

- Thunder Bay
- Kakabeka Falls

OTTAWA
Locations:

- Greely

ATTACHMENT III

List of Regression Equations for Thermal Load and GSHP Load

A. Type I Homes

1. Customer #14
   Thermal Load=3.44495331-0.27094321*Temperature
   GSHP Load=1.32350503-0.10851078*Temperature

2. Customer #20
   Thermal Load=3.90581065-0.21118733*Temperature
   GSHP Load=1.94740312-0.10543446*Temperature

3. Customer #21
   Thermal Load=2.65946906-0.17195238*Temperature
   GSHP Load=1.14817745-0.07873382*Temperature

4. Customer #22
   Thermal Load=2.96280359-0.25617749*Temperature
   GSHP Load=1.00522212-0.08611870*Temperature

5. Customer #23
   Thermal Load=4.44399053-0.21335361*Temperature
   GSHP Load=1.70944131-0.07433721*Temperature

6. Customer #25
   Thermal Load=3.53737829-0.024383498*Temperature
   GSHP Load=1.33023091-0.09379265*Temperature

7. Customer #26
   Thermal Load=3.70513290-0.18773811*Temperature
   GSHP Load=1.41204180-0.07369841*Temperature

8. Customer #27
   Thermal Load=4.51704856-0.26865170*Temperature
   GSHP Load=1.69667482-0.10083398*Temperature

9. Customer #29
   Thermal Load=3.48770468-0.27935089*Temperature
   GSHP Load=1.32350503-0.10851078*Temperature

10. Customer #30
    Thermal Load=5.10686583-0.18491701*Temperature
    GSHP Load=1.91649470-0.07400094*Temperature

Continued...

11. Customer #31
Thermal Load=2.89865258-0.15114565*Temperature
GSHP Load=1.08065258-0.05951686*Temperature

12. Customer #32
Thermal Load=4.88629298-0.28582896*Temperature
GSHP Load=1.90527286-0.11603863*Temperature

13. Customer #33
Thermal Load=3.22828797-0.17643724*Temperature
GSHP Load=1.09541416-0.06526459*Temperature

14. Customer #34
Thermal Load=3.22828797-0.17643724*Temperature
GSHP Load=1.09541416-0.06526459*Temperature

15. Customer #35
Thermal Load=2.58083307-0.15049857*Temperature
GSHP Load=1.58621049-0.10018536*Temperature

16. Customer #36
Thermal Load=2.82107057-0.17945465*Temperature
GSHP Load=1.57709611-0.10095995*Temperature

17. Customer #76
Thermal Load=5.90906473-0.34128892*Temperature
GSHP Load=2.11989429-0.08008761*Temperature

18. Customer #77
Thermal Load=7.43019093-0.30012317*Temperature
GSHP Load=2.57399070-0.07368001*Temperature

19. Customer #78
Thermal Load=5.17882961-0.14706049*Temperature
GSHP Load=2.09012543-0.06644540*Temperature

20. Customer #200
Thermal Load=4.00739194-0.20524259*Temperature
GSHP Load=1.67774492-0.08943765*Temperature

21. Customer #201
Thermal Load=3.41887747-0.17741867*Temperature
GSHP Load=1.28364627-0.06390640*Temperature

Continued...

ATTACHMENT III

B. Type II Homes

1. Customer #37
   Thermal Load=9.61513273-0.51055139*Temperature
   GSHP+Plenum Load=3.21077709-0.47373263*Temperature
   GSHP Load=3.774426166-0.21396889*Temperature
   Balance Point Temperature=-2°C

2. Customer #38
   Thermal Load=9.12503844-0.38799991*Temperature
   GSHP+Plenum Load=3.15312938-0.34111124*Temperature
   GSHP Load=3.54284197-0.16496009*Temperature
   Balance Point Temperature=-2.2°C

3. Customer #39
   Thermal Load=11.26202583-0.42906142*Temperature
   GSHP+Plenum Load=4.30518285-0.46712791*Temperature
   GSHP Load=4.34453115-0.19308639*Temperature
   Balance Point Temerpature=-0.14°C

4. Customer #40
   Thermal Load=9.87800706-0.37285794*Temperature
   GSHP+Plenum Load=3.50811125-0.29827558*Temperature
   GSHP Load=3.81242275-0.17382492*Temperature
   Balance Point Temperature=-2.4°C

5. Customer #41
   Thermal Load=8.67107419-0.43672756*Temperature
   GSHP+Plenum Load=2.13881284-0.49695976*Temperature
   GSHP Load=3.07031699-0.15528904*temperature
   Balance Point Temperature=-2.7°C

6. Customer #86
   Thermal Load=8.90952742-0.35489667*Temperature
   GSHP+Plenum Load=2.75223872-0.29310737*Temperature
   GSHP Load=3.26926569-0.14732634*Temperature
   Balance Point Temperature=-3.6°C